SCIENCE.

FRIDAY, JULY 10, 1885.

A WESTERN SCHOOL OF BOTANY.

In anticipation of the full development of his noble foundation for botany and horticulture at St. Louis, Mo., Mr. Henry Shaw, the venerable founder, has specially endowed a school of botany in Washington university, which will for the present be served by a professor and a laboratory assistant. Professor William Trelease of the Wisconsin state university, a doctor of science of Harvard, has been called to this chair; and we understand that he will accept this hopeful position. When, in the course of time, the Missouri botanic garden, which Mr. Shaw originated, and has for many years so sedulously nourished and supported, comes with its generous endowment into completer connection with this school of botany, it will be seen that this central city in the valley of the Mississippi, happily placed for the purpose, is to have within its bounds an ample establishment for the promotion of botany and its dependent branches (such as arboriculture and horticulture), in the way of scientific advancement as well as of practical and educational teaching.

We understand that a laboratory and its appliances, sufficient for the present, will be supplied at once at the university in the city. But eventually the principal work of the school will probably be carried on at the garden at Tower Grove, adjacent to the park (a gift of Mr. Shaw to the city), which of itself will nearly serve for an arboretum. Here an adequate botanical library and an herbarium (both essentials) will doubtless be provided: we believe there is already a foundation for them. And so, if Mr. Shaw's long-cherished intentions and bountiful provisions are wisely carried into effect, the city in which Engelmann, alone and unaided, pursued his botanical investigations for a lifetime, may before long rejoice in the possession of much better facilities and larger means for botany than any other part of our country has now, or is likely to have. May the success of the new school of botany be commensurate with such advantages!

SANITATION AND SCIENCE.

Practical sanitation is devoted to the prevention, avoidance, or destruction of the causes of disease and death, and is founded on our knowledge of these causes. This knowledge is the scientific aspect of hygiene, or what many call sanitary science. It is at present very fragmentary and imperfect. Our powers of prediction as to the effect which certain circumstances will produce on the health of an individual or a community are limited, and in many cases we cannot, with any approach to scientific precision, explain why a given locality is, or is not, unhealthy. The first step towards a scientific investigation of a phenomenon must be the verification of its existence; but in much the larger portion of this country we can obtain little positive information as to the extent to which the inhabitants of a given place are liable to special forms of disease, or even as to the death-rate to which they are subject.

Until within a comparatively recent period, the method which has been almost exclusively employed in the investigation of problems of public hygiene has been that of observation of general and special mortality rates in different communities, and of endeavoring to connect the results of such observations with the circumstances of the environment in order to discover the causal relation between the two. But in such complicated biological problems as these, in which the result observed may depend on the concurrence of many causes or circum-

stances, it is usually very difficult, and often impossible, to obtain precise knowledge by mere observation of results, even when such observation can be made accurately. The most rapid and satisfactory progress is made when we can subject the problem to the test of experiment, and, by varying the conditions at our pleasure, can thus determine those which are essential to any particular result which may appear.

This experimental method is now being applied to sanitary questions, and especially to those connected with the prevention or suppression of the infective or spreading diseases, which are those of most interest in public hygiene. We can now study the causes of splenic-fever, erysipelas, infectious pneumonia, tuberculosis, glanders, and probably cholera, in the laboratory as well as in the sick-room; their causes may be cultivated, like plants, and the effects of various foods, temperatures, etc., upon them determined; and the efficacy of means proposed for eradicating them may be tested by direct experiment.

It is true that as yet comparatively few diseases can be thus investigated; because for the majority we have not yet found any animals, other than man, who are susceptible to them, and we cannot use man for inoculation experiments. We cannot say whether we have present in a specimen of water or a piece of clothing the specific cause of typhoid-fever, or of yellow-fever, or of scarlet-fever, except by tests applied to man; and hence we can only surmise with more or less probability as to whether such causes exist in a given well, or ship, or bale of rags. Nevertheless, the progress has been so great during the last five years, that we have every reason to hope that science will before long be able to use her right hand (experiment) to aid her left hand (observation) in unravelling not a few of these tangled skeins.

It is no longer a satisfactory explanation of an outbreak of diphtheria or typhoid to say that the place was filthy: if that were a sufficient cause, there are few towns that would not soon suffer from epidemics of these diseases. The apparent anomalies in the distribution of disease, which are apparent to every one who has investigated the subject, — the good health of persons who work in the midst of offensive effluvia and typical filth, the progress of an epidemic along one side of a street while the other side is free from disease, the people who drink dilute sewage with impunity and enjoyment, — all these things are illustrations of our own ignorance, and not of variability in natural law, to which all alike must be subject.

For every person who is affected with typhoid, or cholera, or tubercle, there are fifty who, so far as we can see, have been exposed to the same causes, and remain unaffected. It is easy to find instances where children have slept with others affected with scarlet-fever without contracting the disease. We cannot say to a person, "If you let your child visit his playmate sick with scarlet-fever, he will contract the disease:" we can only say that it is very probable that he will do so. In like manner, we cannot say to the inhabitants of a town or village where the wells are within a few yards of leaky privy-vaults, "You will have typhoid or cholera:" the probabilities may be only one out of four or out of ten that this will happen.

Sensible people take some precautions when their cattle are in such danger: they insure their houses and barns against much smaller probabilities of loss, but they have not yet learned that it also pays to insure against disease.

This instruction must be given them, not in the form of spasmodic declamation and vague threats, but as clear, definite information, distinguishing carefully between that which is known, or sanitary science, and that which is only more or less probable; and scientific investigators, whether chemists, geologists, biologists, or physicians, must all aid in the work. Their special knowledge gives them power, and it also imposes on them responsibility, — a responsibility which, if neglected, may result in crippling their chosen work and filling their own homes with sorrow.

QUARANTINES AND THEIR SCIENTIFIC VALUE.

THE outbreak of cholera in Europe during the past summer has naturally awakened a lively interest in precautionary measures to prevent its access to this country. The experience of all epidemics shows that among the chief and first obstructions suggested is that of quarantines. From their early application against the progress of plague in Italy, to their latest use during the past summer to prevent the introduction of cholera in Spain and Italy, this institution has met with indifferent success in preventing the spread of an epidemic; so that to-day the practical question of its efficacy remains still unsettled in the minds of many. Indeed, there is a large and influential number who inveigh against all quarantine measures as useless in a sanitary point of view, and as causing needless obstructions to the free intercourse of persons and commerce. It will be the object of this paper briefly to review the position, and establish, if possible, a reliable stand-point from which the work of sanitarians may be rationally carried on.

To approach the subject properly, we must first disabuse our minds of many European prejudices and ideas. So much of our medical literature comes from these sources, that we insensibly adopt conclusions drawn from these writings, without considering the differences of geographical position, and the facility which this gives us of employing measures which may be impracticable in most of the European countries. While this would eminently be the case, even were the conclusions reached by European governments founded on the recognized natural history of epidemics, another element of distrust is presented when we know that other factors enter into and bias their writings.

Governmental jealousies, geographical positions, impeded commercial relations, the difficulty of demonstrating an intangible element, with the consequent contrariety of opinions, have each and all tended to perpetuate the diversity of measures taken by different governments to obstruct the progress of a scourge. The several international sanitary congresses which have from time to time been held since the outbreak of the first cholera epidemic in 1831, have rarely been harmonious in action, adopting their conclusions mostly by a majority vote, or, if harmonious, the governments they represented have often failed through interested motives to give them cordial force and efficiency. Particularly is this notable with the English. Cholera is endemic upon a large area of her richest possessions. Her commercial relations with these countries are constant and immense. Any action taken to repress the spread of cholera must contravene more or less these relations, and is met either by evasion, or distinct refusal to adopt such action.

Her medical men insensibly imbibe the same spirit; and we find her medical literature teeming with articles on 'epidemic influence,' 'non-contagiousness of cholera,' the 'non-efficiency of quarantine,' 'cholera purely a filth disease,' etc.

While there is much in these writings which should command respect and attention, particularly in all that pertains to local sanitation, we should notice that their principal value lies in restricting and jugulating a scourge once admitted, rather than preventing in the first instance its ingress to the country. The geographical position of the different nationalities of Europe with respect to one another precludes the application of the principles of quarantine as understood in this country. Land quarantines have always proved ineffectual: and there is but one spot where quarantine applied to vessels can hope to be effectual against the incursion of cholera; that is the one established within the past few years at the island of Camaran, at the entrance of the Red Sea. In a paper recently published, I have detailed the principles and purposes which actuated the European international sanitary commission in its establishment.[1] If the regulations established at this point are faithfully carried out, the danger from cholera, so far as its transportation by Mohammedan pilgrims is concerned, should be effectually prevented.

Before making our estimate of the efficiency of quarantine measures to prevent the incursion of an epidemic, we must consider for a moment the position of this country with reference to the two great scourges which it is desired to contravene. In no part of this country are cholera or yellow-fever endemic: neither can reach our shores except through the intervention of shipping. The time of transit from Europe is longer than the incubative period of cholera; to all northern ports, from Havana, it is nearly equal to the incubative stage of yellow-fever: disease, therefore, contracted before going on the ship, would be developed before arrival at our ports. We shall see, when we speak of the detail of measures for repression, that a vessel, so far from being unfavorable, is really an efficient spot to jugulate cholera. The same rule does not apply to yellow-fever.

[1] New-York *Medical record*, April 18, 1885.

But what, then, is quarantine as understood in this country? Is it mere blind repression, established through the instinct of fear, and calculated to obstruct all intercourse among nations, both personal and commercial? Dealing with intangible agencies, is it equally vague in its principles of repression? The term is an unfortunate one; for it naturally carries us back to the derivation of the word, with all its inconveniences and sufferings of detention, its useless and blind precautions, its superstitions and silly forms as practised for centuries in the south of Europe, and as enforced in Spain and Italy even during the past year. It has no such meaning to-day, but comprises the whole series of measures, hygienic as well as restrictive, employed to contravene the incursion of an epidemic. These are not limited to those taken at the port of arrival of a vessel, but include those which in my judgment are far more important, — the inspection of passengers and *luggage* before embarkation, the systematic inspection of passengers in transit, and, finally, their observation and inspection on arrival at port. The underlying principles upon which its workings are based, are the modes of transmission, and the period of incubation of the disease to be contravened. Intelligent quarantine, while working on these principles, will vary the details according to the locality to be protected, and the particular disease to be excluded. The series of measures necessary to repress cholera would in no way be applicable to the exclusion of yellow-fever, for they are transmitted by wholly different agencies. Cholera, while the most pandemic of all epidemics, is also among the most contagious, or, rather, secondary influences enlarge widely the sphere of the contagious influence; while yellow-fever, limited to certain zones and altitudes, is non-contagious, its transmission depending wholly upon the surroundings of man. Strange as may seem the assertion, a ship should be one of the best places to jugulate cholera; for if due precautions of cleanliness, and disinfection of discharges, are promptly made, we avoid the secondary sources which arise from soil and contaminated water. On the other hand, yellow-fever, appearing on shipboard, can have no ending, so long as there is fresh material upon which to feed, short of seeking a zone where it loses its virulence, or discharging the vessel, and subjecting it to the most minute cleansing and purification.

In an article of this kind, it is unnecessary to recite the details of measures of repression of the two diseases, based on the above principles. I have already done so in the article 'Quarantine,' in Buck's 'Hygiene,' and the paper referred to, lately published in the *Medical record*. There are, however, two or three points to which it is well to refer, and the discussion of which may correct popular misapprehensions. I have stated that the time of transit from European countries to our shores is longer than the incubative period of cholera. If, therefore, by careful inspection of all soiled clothing at the point of departure, this factor for conveying the disease is eliminated, we have only to watch the development on shipboard of such cases as may have acquired the disease before coming on the vessel. The moment a case is recognized, or even suspected from any diarrhoeal discharge, it should be promptly isolated, attendants quarantined, discharges at once disinfected, all soiled clothing promptly destroyed, attendants' hands washed for the slightest stain, and it would be promptly suppressed. There is here but the primary factor with which we have to deal. The secondary ones, of contaminated water, floating germs, and conditions of the soil, are absent. If efficient measures are taken, a ship should be a favorable place to repress the disease. It would remain, then, for the land quarantine to maintain the vessel under observation for the requisite time to determine that no new cases occur. A series of measures which would suggest themselves promptly to any health-officer should be taken; such as the removal of all from the vessel to a spot of absolute isolation, the thorough cleansing and disinfection of all the cabins, linen, etc.

While yellow-fever may be transmitted by any of the surroundings of an individual, its favorite habitat is in the filth which accumulates in the bilge of a vessel. Nothing short of reaching this filth, and removing it with the most scrupulous care, can insure a protective influence. Disinfectants, fumigations, great heat in its various applications, are but secondary adjuvants, to be employed only after most scrupulous cleanliness has been effected. I believe in the efficiency of quarantine, if the measures recited cursorily above are rigidly carried out. They are measures to which the most minute attention must be given in every detail. The neglect to carry out any single provision will cause failure, and throw discredit upon the system.

It is a subject of interest to consider the influence of steam-navigation upon the dissemination of cholera and yellow-fever. As neither disease travels faster than man himself (for I discard the theory of 'epidemic influence'),

it would seem, at first view, that the increased rapidity of travel would also disseminate more rapidly the scourges; and yet it has seemed to me the practical working is the reverse. Those familiar with the history of cholera among the Mohammedan pilgrims are aware that since the abolition of caravans, and the transportation of pilgrims by steamers, very many fewer cases of cholera occur at Mecca, and along the land route from Dejeddah. It is because all are kept, so to speak, in a certain lane, where they are under constant observation; their food and hygienic surroundings are more carefully regulated; and cases occurring can be promptly treated and guarded. The same is true of steamers bringing emigrants to this country. With competent medical officers, isolated hospitals, absolute cleanliness of attendants, and prompt disinfection of discharges, the disease should be limited to those who had contracted it before coming on board, and virtually suppressed by the time of their arrival at any one of our seaports.

This influence of steam-communication is more striking, though in a different way, with reference to yellow-fever. In the great majority of cases, the vessel is the means of transportation; and the particular place of preference for the poison is, as stated above, in the filth which accumulates in the bilge. In sugar and milado carrying vessels, this, in a tropical climate, soon develops fermentative action. Until within a few years, the commercial history of vessels trading with yellow-fever ports has been as follows: A European cargo is taken to Havana, discharged, and the vessel lies an indefinite time empty in an infected port, seeking a charter for some seaport in the United States. No particular precautions of cleanliness are taken, either as regards the vessel or the crew. In most cases the fever appears while lying in port. A cargo is at length obtained, which adds to the filth of the bilge already infected. A better nidus for the propagation of the poison could not be formed; and under a tropical sun, sealed hatches, and stagnant air, it intensifies with great rapidity. An experience of several years showed that the majority of cases brought to the port of New York were on vessels of this character. Within the past ten years a radical change has been going on, and steam-transportation has largely replaced sailing-vessels, and with it there has been a large diminution in the number of the cases of yellow-fever. Steamers belong to regular lines, which make frequent and regular trips, remain but a short time in port, and are therefore rarely infected. Being of iron, their construction enables one to reach the bilge with facility, while the steam-pump flushing it keeps it clean: there is no wood to saturate and become infected. A steamer, too, carries the cargo of several sailing-vessels, and lessens the risk in that proportion. So far, then, from the rapidity of steamers facilitating the spread of cholera and yellow-fever, they have been the means indirectly of retarding both.

It could also be easily shown that the long antagonism between commerce and quarantine has entirely passed away. Instead of vessels riding an indefinite quarantine, our knowledge of the natural history of the two diseases tells us that the sooner a vessel is emptied, the less the danger of transmission of disease. Vessels, therefore, in quarantine, are returned to commerce sooner than if they went to dock, and discharged through the usual routine.

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HOW TO DEAL WITH YELLOW-FEVER.

IN closing a report on the yellow-fever epidemic of 1873, made in response to a resolution of the U. S. senate, the present writer used the following language: —

> "It may finally be added, that, in the absence of other adequate cause, the gradual narrowing of the yellow-fever zone in the United States during the past fifty years — say, from the time when leases in New-York City frequently contained a provision for reducing the rate of rents in the event of a depression of business from the advent of cholera or yellow-fever — may be fairly claimed for the sanitarian and his efforts; and that in such efforts lies all there is of promise for the future in dealing with yellow-fever."

This was written before the brilliant results of the investigations of Pasteur and Koch had opened up the tempting field which Ferrán and Domingos Freire already claim to be successfully cultivating. It may be that these gentlemen have actually accomplished — the one for cholera, and the other for yellow-fever — what Jenner, Pasteur, and Koch have done for other diseases; and although this is not yet proven, and, in the nature of the case, will require considerable time to demonstrate, there is scientific ground for believing that immunity against these pestilences will eventually be secured through a process analogous to that by which vaccination has disarmed small-pox of its terrors. Until that desideratum is reached, however, the precautions which should be taken to provide against yellow-fever will

continue to be those indicated in the sentence above quoted.

Whatever the yellow-fever poison may ultimately prove to be, enough is already known of its characteristics and limitations to enable us to formulate specific measures of such precaution. For practical purposes, we are not concerned with the many theories regarding its origin, — whether it was first engendered during the horrors of the 'middle passage' in the hold of an African slaver, or in the putrefaction of the abundant marine life of the Sargossa Sea, or by the action of atmospheric forces peculiar to the equatorial Atlantic, or by the spontaneous development of a specific organism. It is sufficient to know that there is such a poison, and, 1°, that while it does not originate in this country, it may be conveyed from place to place; 2°, that it is a poison of considerable specific gravity, infecting the lowest stratum of the atmosphere, and possesses great tenacity, clinging to surfaces; 3°, that it flourishes amidst filth, under certain conditions of temperature and moisture; and, 4°, that the disease which it produces is essentially one of cities and crowded populations.

Upon these characteristics must be based the precautions to be enforced, and first with regard to communication with places where the disease is endemic. A quarantine of absolute exclusion is demonstrably impracticable, owing mainly to the many facilities which steam enables commerce to command. Much, however, may be done in this direction by a quarantine of inspection and sanitation. To this end it is necessary, that, within the geographical limits where yellow-fever may become epidemic in the United States, a system of sanitary supervision over personal and commercial intercourse with places where the disease exists endemically be established and maintained during the season when the atmospheric conditions necessary to its epidemic spread obtain in this country. This would dictate specifically that such supervision over commerce with South-American ports lying north of 22° south, with the West Indies and the Bahamas, and with the east coast of Mexico, should begin in April at the Gulf and South-Atlantic ports, and in May at ports north of 32° or 33° north, and should continue until the close of October and September respectively.[1]

[1] Of a hundred and seventy-four epidemics, of which the date of beginning has been accurately recorded, three began in May in places south of latitude 33° north, but none earlier than June in places north of Charleston (32° 46′ north): four began as late as October in the former, but none later than September in the latter. Hence south of Charleston the danger season begins in April, and ends in October: north of Charleston it begins in May, and ends in September.

The supervision should consist of an inspection of every vessel arriving from the region specified, and of treatment, which will vary, 1°, with the actual sanitary condition of the vessel, her cargo, belongings, and *personnel*, including in the sanitary condition the facts as to age, material, and previous yellow-fever history; 2°, with the sanitary status of the port of departure; and, 3°, with the climatic and other conditions of the port of arrival. Within the limits assigned to this paper, it is not possible to enter into the details of this treatment. They are well understood by practical sanitarians, and their sufficiency has been demonstrated by the inspection services of the National board of health and the Sanitary council of the Mississippi valley, as well as in the quarantine practice of the port of New York and elsewhere; while a practical test of their value for the protection of the port of New Orleans is now being made by the Louisiana state board of health. The characteristics of the poison, as set forth in the second and third propositions, will indicate what methods of treatment by disinfection and cleansing are necessary.[1]

But no matter how perfect such a system of sanitary quarantine may be made, there is always the risk of the poison being introduced through some unsuspected, and therefore unguarded, channel.[2] To meet this risk leads to further consideration of the third proposition, — that the poison flourishes amidst filth.

Whether the disease is in its indigenous

[1] Assuming that yellow-fever is "due to a specific cause which is capable of growth and reproduction," and which is transportable, not only by adhesion to surfaces, but in the air from an infected locality; and that the "growth and reproduction of this cause [i.e., the yellow-fever poison] is connected with the presence of filth, in the sanitary sense of that word, including decaying organic matters and defective ventilation," — it follows that closed vehicles, compartments, or receptacles, and articles or masses of material capable of retaining air motionless in meshes, folds, webs, or interstices, are dangerous as contagion-carriers in proportion as their character, use, or structure prevents or retards aeration, and in proportion as such articles or materials furnish organic matter liable to decay: hence an empty box-car, or the unventilated hold of a vessel in ballast, may be the means of introducing the poison by transporting infected atmosphere . . . [extract from a "Memorandum for the classification of articles of merchandise for quarantine purposes," drawn up by the writer, and adopted by the Sanitary council of the Mississippi valley, April 21, 1881].

It will be seen from the above that the disinfection necessary for yellow-fever is essentially different from that laid down by the recent International sanitary conference at Rome as sufficient for cholera. In the report of the committee of that conference on the question of disinfection, and which embraces such eminent men as Koch, Sternberg, and Proust, it is specifically stated that 'disinfection of merchandise and of the mails is unnecessary;' while, of atmospheric disinfection, no mention whatever is made in the report. That these are both essential for yellow-fever, is, in the opinion of the writer, beyond question. His personal experience during the epidemics of 1878–79 alone — notably, that on the relief-boat Chambers, in connection with the infection of Lieut. Benner and others — is to him conclusive on this point.

[2] Intercommunication with Mexico by rail, for example, suggests one mode which as yet has not been provided against; although an extension of the system of sanitary supervision to railroad intercourse is entirely feasible, as has been shown during the past few years by the operations of the inspection services above referred to.

home, or imported, the testimony is uniform that epidemics of yellow-fever have their starting-points in the lowest, filthiest quarters of seaport towns, than which nothing can be filthier or more disgusting. It can hardly be necessary to dwell upon this point. With the improvement in the water-side precincts of New York, Philadelphia, and other North-Atlantic seaports, yellow-fever has ceased to be the devastating pestilence which it was in the days of Benjamin Rush. In those days the purlieus of such cities were little better than they now are in the towns and cities of the Spanish main, where it still rages. In the latter, it is true, there is always present the added factor of a favoring condition of temperature; and, less constantly, this also affects our Gulf and South-Atlantic seaports. But this of itself should be an additional incentive to securing the best attainable sanitary condition. Foul drains, filthy streets, reeking gutters, neglected cloacae, excremental accumulations, decomposing garbage, rotting fruit and vegetables, the drainage of sugar and molasses casks, — the wonder to the sanitarian, as he views such scenes for the first time under the tropical rays of a summer sun, is not that yellow-fever occasionally occurs, but that pestilence in some form is not always present. In the endemic home of yellow-fever, 'sanitation' is an unknown term; and, in the degree that its import is ignored along our Gulf and South-Atlantic coasts, the disease finds favorable conditions for establishing itself whenever its poison is introduced.

An obvious precaution is suggested by the fourth proposition, — that yellow-fever is a disease of cities and crowded populations.[1] As a rule, it is limited not only to cities, but to sharply defined quarters of cities. The great specific gravity of the poison, and its property of clinging to surfaces, are shown in this limitation of extension. Frequently its rate of progress may be mathematically defined, so many feet per day, independent of any recognized influence, except a perpendicular obstacle. A board fence has been known to stop its progress, as in Mobile; or a bluff bank to hold it at bay for weeks, as in Memphis. Not only do the higher portions of a city suffer less than the lower, other things being equal, but the upper stories of individual houses are safer than the lower. Yellow-fever is essentially a local disease, its existence depending upon particular circumstances of place: hence, when the disease manifests itself in a locality, the imperative duty of the sanitary authority is to remove from the infected place (be it house, street, ward, or quarter) all those susceptible to it, — to depopulate the infected district, if it tends to become epidemic, by removal to camp, if only a few miles distant, as was done with such satisfactory results in Memphis during the epidemics of 1878 and 1879, and repeatedly before that time in the U. S. army. The *cordon sanitaire* may be employed to prevent people from going into an infected district; but with the present resources of sanitary science, and definite knowledge of this disease, its use to prevent escape from such a district is a barbarism of the same character as the old-time quarantine of detention.

[1] Its occasional extension to small places, and even to plantations and isolated houses, does not affect the general accuracy of this proposition. Such extension occurs only during wide-spread and virulent epidemics, when, it may be inferred, the specific poison is generated in such quantity and intensity as to be the more readily transplanted from place to place.

In a word, the precautions to be taken against yellow-fever are the same as those which common sense and experience have shown to be adequate against the other exotic infective diseases: to wit, a thorough system of sanitary supervision and control of intercourse, both by sea and land, for the exclusion of the specific poison; and, supplementing possible (if not inevitable) defects in this, the destruction of the conditions necessary to the life and activity of the poison by general and local sanitary effort within our own territory.

F. W. Reilly.

CHICAGO-RIVER POLLUTION.

It is worthy of note that the first sanitary regulation made by the authorities of the town of Chicago had reference to the protection of the river from pollution. Nov. 7, 1833, the town trustees declared it to be unlawful "to throw or put into the Chicago River, within the limits of the town, any dead animal or animals, under a penalty of three dollars for every offence." More than half a century later, the problem of establishing and maintaining an inoffensive condition of this stream still demands the attention of the sanitarian. A glance at the topography of the region will facilitate comprehension of the problem, and assist in its solution.

While the western portion of Cook county is embraced in the general slope of the watershed of Illinois and the interior system of drainage of the State, — which is to the south and west, and ultimately into the Gulf of Mexico, through the Mississippi River, — the region of Chicago, embracing the greater portion of Cook county, drains naturally into the Gulf of St. Lawrence, through the Great Lakes

and the St. Lawrence River. The site of the city was once covered twenty feet or more by the waters of Lake Michigan, whose western rim, at no very remote period of geologic time, was some eight or nine miles west of its present position with reference to the city of Chicago. The recession of the lake resulted in the formation of a series of sand-dunes or ridges, with intervening ponds and lagoons, which gradually filled up with the humus of peat-producing vegetation. This formation was the original site of the city, with an average elevation of only twelve feet above the lake, and much of it being so low as to be subject to overflow, even by the ordinary variation of the lake under the influence of north and north-east winds.[1] Through this low, flat, swampy plain there eventually cut its way to the lake a narrow, sluggish stream, the present Chicago River. Forking about a mile and a half from its present mouth, its north branch runs in a direction generally parallel with the lake shore for a distance of some twenty miles; while its south branch, after running due south for about two miles, tends sharply to the south-west for a mile or more, and then divides into two smaller branches, the western one of which is separated from the Des Plaines River by a narrow 'divide' of only a few feet elevation. In seasons of high water, this 'divide' was formerly obliterated by the flow of the Des Plaines into Lake Michigan, and for several years an artificial communication has existed between these two streams through the so-called 'Ogden ditch.' In 1848 the Illinois and Michigan canal was completed, connecting this south branch of the Chicago River with the Illinois River at La Salle, ninety-six miles south-west; and in 1871 the summit-level of the canal, twenty-six miles long, had been lowered from twelve feet above, to eight feet and a half below, the ordinary level of Lake Michigan: so that, theoretically, the Chicago River now rises in Lake Michigan, and empties into the Mississippi through the Illinois and Michigan canal and the Illinois River. The primary object of the construction of this canal was purely commercial, but it has since become one of the most important factors in the sanitary welfare of the city.

As the cholera epidemic of 1849–50 led directly to the introduction of lake-water, and the foundation of what is, in some respects, now the most magnificent system of water-supply in the world, so the repeated epidemics of cholera and dysentery led to the adoption, in 1856, of a system of sewerage, which, within twenty-four years thereafter, had furnished more linear feet of sewers *per capita* of population than in any other of the large cities of the Union. For fourteen years (1843–56 inclusive[1]) the average annual death-rate of the city had been 37.91 per thousand, probably the highest of any city in the United States; during the first fifteen years of sewer-construction (1856–70), the average annual death-rate was reduced to 23.97 per thousand; while, from 1871 to 1884 inclusive, the average has still further fallen to 21.40 per thousand. And although there have been marked fluctuations from year to year, — rising to 32.22 in 1866, and falling to 16.49 in 1878, — on the whole, there is, as I have shown in a table published elsewhere,[2] a striking correlation between the annual death-rate and the number of feet of sewers *per capita* year by year, independent of all other influences.

But while the sewerage of the city has been one of the most important agencies in this reduction of the death-rate, it has necessarily added to the pollution of the river and its branches, and from time to time has affected the purity of the water-supply. To such proportions did this evil speedily attain, that in July, 1860, — only four years after the system was adopted, — the sewerage commissioners recommended that the canal be deepened and enlarged, so as to create a constant current from the lake into the Illinois River, as a measure indispensable to the protection of the health of the city. The recommendation was not heeded at the time; and for some years thereafter, Mr. Chesbrough, the sewerage engineer, continued to urge, as a practical measure of temporary relief, the construction of covered canals or aqueducts from the lake, with apparatus for forcing lake-water through them into the north and south branches respectively, and so to create a current from the river into the lake, pending the construction of a system of intercepting sewers or the deepening of the canal, — both of which measures he had ably discussed from time to time, from the year 1855.

Meanwhile the volume of sewage and of offal from the slaughter-houses and other sources, pouring into the river, continued to increase with alarming rapidity; and although the foul-

[1] The highest point above the level of Lake Michigan, for fifteen miles north, is only thirty-eight feet; and south-east for the same distance, only twenty-three feet. Directly south of the city, the surface is almost level, the highest point within sixteen miles being only twenty-two feet. Southwest for ten miles the highest point is only ten feet, where, at the Summit, the waters of the St. Lawrence run north-east, and those of the Mississippi south-west. From the Summit there is a gradual descent, until the ground is lower than the surface of the lake.

[1] Certificates of causes of death were first required in 1841, but records were not begun until June 1, 1851.

[2] 'The sanitary problems of Chicago, past and present.'

ness was occasionally mitigated by the action of the pumps at Bridgeport, raising water from the south branch into the canal as needed for navigation, it was not until the spring of 1865 that it was finally decided to deepen the canal, as had been recommended in 1860. A remarkable epidemic of erysipelas, which prevailed exclusively along the south branch and main river in 1863, and which was obviously caused by the unspeakable filth of these streams, had undoubtedly much to do in securing this decision; but the efficiency of this mode of relief had been incidentally shown by the action of the pumps at the head of the canal. The work was begun in the fall of 1865, and completed in July, 1871; but even before it was completed, the water-supply, taken from a point about one-fourth of a mile from the shore, had been so often affected by the current from the river, that a tunnel under the lake, running out two miles farther, was constructed, for the purpose of getting the supply from beyond the area of river-pollution.

Relying upon the deepening of the canal to establish and maintain a cleansing current from the lake through the river, the pumps at Bridgeport were removed when the 'deep cut' was completed, notwithstanding which there was for some time a decided improvement in the condition of the river. Gradually, however, the increased sewage-production of the rapidly growing city, a diminution of flow through the canal due to various causes, and the fluctuations of the lake-level, indicated the necessity for further effort.[1] In 1871 the construction of the 'Ogden ditch' was begun; and after its completion another factor was added to the problem, — a factor which acquired additional importance, when the dam and floodgate intended to regulate the flow through the ditch were broken down, and became inoperative. The Des Plaines pours through this ditch into the south branch a volume often greater than the entire capacity of the canal. Every cubic foot of this water reduces by so much the inflow of the lake through the main river and south branch into the canal, and thus causes a concentration of the pollution.

In 1881, after careful study of all the conditions, I urged the re-establishment of the pumping-works at Bridgeport, recommending that their capacity be made sixty thousand cubic feet per minute, and subsequently pointed out the necessity for the re-establishment of the dam at the 'Ogden ditch.' An appropriation was promptly made for the pumping-works, and these were completed late in the fall of 1883; but thus far they have not pumped over thirty-five to forty thousand cubic feet per minute. Within a short time an appropriation has also been made for the repair of the dam.[1]

At the present time the fouling of the river and its branches from the blood, offal, and wastes of the slaughtering and packing establishments and their subsidiary industries, has been materially reduced by the utilization of much which was formerly considered worthless, and consequently was thrown into the river or upon the surrounding prairies. On the other hand, the volume of sewage proper has increased with the growth of the population and the extension of the sewered area, until a daily sewage-production, which may be roughly estimated at from forty-five to fifty million gallons, is now poured into the river and its branches. With the exclusion of the waters of the Des Plaines River from the canal, and the continuous operation of the pumping-works, this sewage need never be allowed to find its way into the lake, except for a short time during the spring thaws, or as the result of unusual rainfalls; and these exceptional occurrences will not then entail serious consequences, owing to the permanently improved condition of the river and its branches, resulting from the continuous removal of the sewage, and the cleansing effect of the steady influx of lake-water.

It should be stated that provision is made for the purification of the north branch of the river, as originally suggested by Mr. Chesbrough, through a conduit from the lake, with pumps capable of pouring eighteen thousand cubic feet of water per minute into the branch at Fullerton Avenue. To prevent this from creating a current into the lake through the

[1] The lake is highest in July and August, and lowest in December and January, the average fluctuation being about three feet. Occasionally it is much greater than this: for example, on one occasion in February, 1875, the stage of water at the head of the canal was only five feet and eleven-hundredths, while for a short time in April, 1877, it was fourteen feet. Local rains on the watershed of the south branch, or on the area drained by the summit-level of the canal, or high water in the Des Plaines pouring into the south branch through the 'Ogden ditch,' — all operate, to a greater or less extent, in the same way that a low lake-level does; that is, the current in the south branch and main river is suspended or reversed, and, instead of flowing off through the canal, the sewage is carried into the lake in dangerous proximity to the in-take of the water-supply at the 'crib.' This condition obtains every spring for varying periods, and during the spring just closed it was frequently observed. A local rain on the 2d of this month (June) created a current from the river, which continued for several days, the effect being perceptible for some distance beyond the 'crib,' until counteracted by north-east winds.

[1] When this is completed, it may be necessary to convey the flood-waters of the Des Plaines to Lake Michigan, at some point north of the city, in order to obviate the danger of inundating the town of Joliet by freshets from a watershed of some twelve hundred square miles. This, however, and the treatment of local areas, are matters of detail which present no features not easily mastered; as, for instance, the fork of the south branch which runs near the Union stockyards, now a foul cesspool. To bring this within the general system requires that an adequate volume of lake-water be poured continuously into the head of the fork, washing its contents, properly diluted, into the south branch, to be thence pumped into the canal.

main river, it is additionally necessary that the Bridgeport pumps be continuously operated.[1]

From causes already indicated, — namely, by the more perfect utilization of wastes and refuse which formerly added to soil and water contamination, and by thorough sanitary supervision and control, — it is probable that the pollution of the Chicago River will be due mainly, in the future, to the sewage proper of the city. This, of course, will increase with the increase of population and the extension of the sewer system. But I estimate, that, at the present time, the river and its branches may be kept in a fair sanitary condition, and the sewage diluted so as to be inoffensive, by causing a flow of from forty-five to fifty thousand cubic feet per minute through the canal: sixty thousand cubic feet will probably be sufficient when the population has increased to seven hundred and fifty thousand. If, by the time the present capacity of the canal is reached, the proposed plan of converting it into a ship-canal has not been realized, it may be necessary to seek additional relief through the Des Plaines River. Pumping-works at the 'Ogden ditch,' discharging into the Des Plaines, may then be used to supplement the discharge into the canal; and for many years these two systems will be adequate to prevent any serious pollution of the Chicago River, will protect the water-supply from contamination, and will relieve neighboring communities along the canal and Illinois River from the nuisance heretofore frequently caused by the sewage-disposal of Chicago.

JOHN H. RAUCH.

[1] The Fullerton-Avenue conduit was constructed, and the pumping-works arranged, so as to discharge the contents of the north branch into the lake through the conduit, or to convey lake-water into the branch. The former method is contrary to the correct principles of the sewage-disposal of Chicago, and must ultimately be abandoned.

SOILS AND HEALTH.

THE soil, especially the first few inches or feet below the surface, is the ante-chamber of life, — the laboratory in which operate incessantly the processes by which inert matter is prepared for the nourishment of life. It is this, because it is also the tomb of all terrestrial living matter. Here is the realization of the Phoenix-myth; the slow combustion of organic matter leaving a residuum, from which springs the new life of succeeding generations.

These processes of the transformation of matter are the work of the low forms of microscopic life which are known as bacteria, and are gifted with the capacity of enormous and immensely rapid multiplication. This world of microscopical life is vast as regards the distribution and number of its living entities. These minute organisms are known to be intimately connected with many of the fundamental processes of the organic world, and our knowledge of their range of activity is constantly increasing.

They may be considered practically to stand in close genetic relations to many diseases; but the question of absolute differentiation of forms with specific functions, or of the possibility of Protean functional characteristics among them, varying with their surroundings, is one of the present great problems of biology.

The great majority of pathologists now consider the infectious, and most of the contagious, diseases to be dependent on these low forms of life; and the tendency is, to consider that certain diseases or groups of diseases are produced only by specific forms of bacteria.

These organisms are wide-spread, especially the various forms that are associated with putrefaction and mould. Only on high mountains, and far from land on the ocean, is the air practically free from them. Elsewhere the air, water, and soil teem with them. Their abundance is necessarily proportionate to the amount of decomposing organic matter in the neighborhood, since they are themselves the scavengers, on which the processes of decomposition depend.

Few people realize what an important part the soil plays in our lives. The water we drink (unless from cisterns) has leached through it. The air we breathe is frequently loaded with its dust. It is in our food.

The soil is highly porous; and the interstices between the grains are filled with water or with air, — 'ground-water' or 'ground-air.' The ground-air fluctuates with the varying barometric pressure, and with the rise and fall of the ground-water in rainy and dry seasons. The ground-water flows according to the common laws of hydrostatics, but with a movement retarded by friction.

A town on a river-flat is built over a continuous sheet of slowly moving subterranean water, and most houses are built where water is accessible within a few feet from the surface. In view of the fact that our wells and the cellars of our houses are in more or less close proximity to these centres of pollution, it was thought desirable to ascertain to what extent the different soils act as filters in arresting the spores of bacteria. This investigation, which was carried out for the National board of health by the writer, assisted by Dr. Smyth, brought out very clearly three facts: —

I. All soils finer than very coarse sand have practically a continuous capacity for arresting the spores of bacteria from infected *air* filtering through them.

II. No soil, no matter how fine, can arrest and hold back the spores of bacteria contained in *water*. The experiment on which this statement rests consisted in filtering unsterilized water through one hundred feet of pipe filled with fine sand which had been sterilized by heating to a red heat. This pipe was connected by an air-tight joint with a flask of sterilized beef-infusion, and the whole apparatus left for several weeks before use. The first drop of water that passed through these hundred feet of sand infected the beef-infusion, causing it to putrefy.

III. Neither bacteria nor their spores can detach themselves from a liquid or from a wet soil, and pass into the air, except through the conversion of the water into spray, or through the formation of dust by evaporation.

The chief practical inferences from these results are, that distances, even of hundreds of feet, between wells and cesspools, are no protection against infection, and that a dry or an alternately wet and dry cellar may be more dangerous than a permanently wet one.

These results emphasize the importance of an intelligent survey of the condition of the soil in selecting a home, and of a legislation prohibiting the pollution of the soil.

In many towns and cities, the privy-vaults and leaching cesspools of every house drain really into the sheet of ground-water: the soil arrests the coarse material, the grease and slime; but the swarming bacteria diffuse with ease, as much as the soluble chlorides and nitrates, and follow the flow wholly unobstructed. Into this same soil are sunk or driven the wells; and the water that is drawn for use is polluted in proportion to the number and proximity of the vaults and cesspools, on the one hand, and the thinness and sluggishness of the water-sheet, on the other. In the worst wells in daily use, the water is distinctly colored with sewage; but the most deadly water may carry only the germs of typhoid-fever or of dysentery, and be otherwise sparklingly clear, and so pure as to pass unchallenged through the most searching chemical analysis.

If the soil is polluted and very coarse gravel, this indraught, loaded with the spores of bacteria, will flow through the cellar to the warmer rooms. If the soil is polluted and fine, and the ground water-surface rises at any season to the level of the floor, or higher, it will evaporate as it oozes into the cellar, and leave an infected dust to be taken up into the circulation of the house-air. Similar results will follow from the leaching of the cesspool toward the cellar-wall, or from the filtration through the soil of sewage from a broken or leaky drain; which is very apt to exist in or just outside of the foundation-wall. The pollutions of soil and water already mentioned are of such a general character, that, with ordinary forethought, they can be guarded against; but there are others of a local character which are not revealed to a general survey. In the growth of many of our cities, the natural topography is disregarded. Lowlands and marshes which are traversed by sewage-fed brooks are covered with a network of high-graded streets, which convert the blocks into sewage-basins, which come, in time, to underlie blocks of dwellings of all classes.

In other cases, low or marshy ground is made the dumping-ground of the city, and receives the sweepings of the street, the contents of the ash and garbage barrels,—every thing, in fact, that cannot pass through the sewers or be sold. The entire material is loaded with organic matter which is kept in a state of very slow decomposition by moisture.

Some of the costliest dwellings of our cities rise upon such soil. We may take every precaution to avoid in our homes the dangers that arise from a polluted soil, and may yet fall victims to the filthy condition of remote places, over which we have no control.

Among many others there are two exceptionally frequent sources of danger of this kind. One of these is the farmer's well, which is rarely safe, and, when not used to adulterate milk, is used to rinse milk pans and cans, and leaves upon their surfaces a source of contamination. The other frequent instance is the use, by druggists, of water from wells or from cisterns, which are often any thing but sewage-proof. Throughout the country, and often in the cities, the use of only distilled water in compounding medicines is far from universal; and I have had analyses made of lime-water bought at a druggist's, which was highly contaminated with organic matter. The druggist's well, moreover, is the source of most of the soda-water throughout the country, as well as in many cities where the water-rates are high. A person having a harmless disturbance of the bowels, arising from a cold, is just in the condition to succumb to the dysentery or typhoid-fever lurking in the medicine or Vichy-water from the too-much-trusted druggist.

Raphael Pumpelly.

CITY WELLS.

AT a conference of state and municipal boards of health held at Washington last December, ten propositions were unanimously agreed to. The first of these is, 'that all surface-wells should be closed at the earliest possible moment.' This has special reference to the surface-wells in cities. Why do these wells deserve such sweeping condemnation? We have only to consider the conditions surrounding them, to have a reason suggested. In cities in which there are no sewers, it is well known that the discharges from the inhabitants are conveyed to cesspools, where they are allowed to remain indefinitely. Sometimes the contents of these cesspools are imperfectly removed; sometimes they are not disturbed, a new cesspool being dug in the neighborhood of one which has become filled. They are rarely built carefully, but are usually merely holes in the ground, lined with sufficient stone-work to prevent the earth from falling in. In some cities they are dug in exactly the same way as the wells which are intended to supply drinking-water. The digging is in each case continued until water is reached. Communication is thus established with subterranean currents, and the refuse matter which finds its way into the cesspools is at least partly carried away. This saves some trouble; but what becomes of the refuse matter? Under very exceptional circumstances, it may find its way to some large body of water which is not used for drinking-purposes, and thus do no harm. If, however, there are wells in the neighborhood, the chances are in favor of the contents of the cesspools and of the wells becoming mixed. The larger the number of cesspools and of wells, the greater the danger of such a result. In a city not provided with sewers, therefore, the conditions are such as to lead almost certainly to contamination of the water of surface-wells with the contents of the cesspools. Besides this, there is the danger of contamination from surface-drainage, which cannot be avoided. The water which falls upon the ground, whether the ground be paved or not, sinks to a considerable extent below the surface, carrying with it such impurities as may be present. Such surface-water in cities, it is safe to say, is always contaminated. Some of it is sure to find its way into the wells.

This latter source of contamination is common to all cities, whether they are provided with sewers or not. While, however, the city which is provided with sewers is not subjected to exactly the same kind of danger as that first referred to above, the cases do not present as much difference as might at first be supposed. The sewers are generally leaky, and the soil in their vicinity becomes saturated with sewage. Thus they may contribute to the contamination of the well-waters. Of course, the danger of such contamination is not so great as when there are no sewers, but still it is quite sufficient to justify the condemnation of the surface-wells.

The waters of city wells have frequently been studied by chemists and biologists, and the results invariably show that contamination is the rule. In Brooklyn, N.Y., there were, in 1882, three hundred and sixteen wells. Chemical examination showed, "that, of this whole number, but seventeen furnished water fit for human consumption." Similar results have been reached in an examination of the water of the wells of Baltimore, where a few years ago there were between one and two hundred in use. The contamination of some of the waters examined was such as to show that very close connection must exist between the wells and cesspools. The testimony of all who have given special attention to the subject of the water of city wells is unanswerable. Not only does a consideration of the surrounding circumstances lead us to suspect that the water must be contaminated, but the most careful examinations, by those most capable of making the examinations, have shown that actually, and almost invariably, the water is badly contaminated.

It is an unfortunate fact, that, though the waters of city wells are generally impure, their external properties do not always reveal the impurity. Sometimes they do; and then it requires but a very slight hint as to the cause of the properties, to stop the further use of the water. Thus, for example, some years ago there was a spring in Baltimore, which, owing to its peculiar taste and odor, was regarded as a mineral spring. It was therefore fenced in, and covered, and generally treated like others of the class known as 'mineral springs.' It was afterwards found that very close connection existed between it and a neighboring cesspool; and the cause of the taste and odor which had given the water its reputation was thus revealed. It need not be added that the water ceased to be popular. More frequently these well-waters are clear, and without taste and odor, and, coming from greater depths than the service-water, they are generally cooler. Frequently, too, they are used for years, and many who use them continue in good health. There are, of course, in every community, many who are able to resist bad influences. They furnish

no evidence for or against the danger of using bad water. The influences are felt principally by the weaker members of a community.

As regards the specific objections which may be raised to using the water of city wells, it may be said, in the first place, that the evidence is pretty clear that water contaminated with sewage does at times give rise to low fevers. Though it is difficult to furnish satisfactory proof of the statement that the use of contaminated water tends to lower the general condition of health of those who habitually use it, those who have paid most attention to the subject unanimously agree that pure water is as important as pure air for the preservation of good health. One of the chief dangers in the use of water contaminated with sewage is, that, by establishing connection between the sick and the well, it contributes to the spread of some forms of epidemic disease. As is well known, it is now held by many of the highest authorities that in some diseases the organisms which are believed to be the active causes are given off from the patients with the alvine discharges. If, now, by any means, these organisms or their germs are introduced into the system of a well person, the diseased condition is set up. What more efficient method of distributing these organisms than drinking water which is contaminated with the contents of cesspools! Exactly what forms of disease may be spread in this way, it is difficult to say; but there is strong evidence in favor of the view that typhoid-fever and cholera are among them. Over and over again, outbreaks of typhoid-fever have been traced with practically absolute certainty to the use of water known to be contaminated by sewage. In regard to cholera, the evidence is quite sufficient to justify the destruction of all city wells.

IRA REMSEN.

THE SHIP-RAILWAY BETWEEN THE ATLANTIC AND PACIFIC.

THE article by Mr. Hubbard, in *Science* of Nov. 4, 1884, on canal routes between the Atlantic and Pacific, discussed briefly the advantages of the three routes and methods proposed. The object of the present paper is to present the scientific and commercial reasons why the ship-railway across the Isthmus of Tehuantepec may be superior to either the Panama sea-level canal, or the Nicaragua lock canal.

It is estimated that $50,000,000 will be ample to put the ship-railway into operation for the transportation of vessels of 5,000 tons. The estimated cost of the Nicaragua canal on a cash basis is $140,000,000, and of that at Panama, as high as $350,000,000.

The route *via* Panama, between Liverpool and San Francisco, is about 700 miles longer than by Tehuantepec; between New York and San Francisco, about 1,200 miles; and between New Orleans and San Francisco, about 2,000 miles. Probably 1,000 miles excess of distance would be a fair average.

The time in transit across the isthmus would be at least three days shorter at Tehuantepec than at Nicaragua for either a steamer or sailing-vessel. The Suez canal, which is 100 miles in length, delays a steamer 48 hours in transit, or her passage is at the rate of about two miles per hour: two-thirds of the distance is through the lakes, and there are no locks. At Nicaragua, about one-sixth of the distance only is through an open lake; and there will be from twelve to twenty locks, at each of which a vessel will be detained nearly an hour. The time required for passage, therefore, will be about four days; so that, although the total distance is shorter than at Panama, the time required for a steamer would be about the same.

In the article by Mr. Hubbard above referred to, reference has already been made to the favorable situation of Tehuantepec with reference to the trade-winds.

It is also hoped that the maintenance will cost much less per annum than that of either canal. The Panama canal being below the level of the sea, with the slopes of its enormous cuts exposed to the wash of the tropical rains, the difficulty of removing the material washed into its prism, and the controlling of the Chagres River, make the maintaining of the ship-channel difficult and expensive. At Nicaragua the conditions are nearly similar.

The ship-railway will not be subject at any point to the ravages of floods. It will be built over its entire length, on the solid ground, with excellent materials at hand for construction and maintenance. On either side is a natural harbor, which with small expense, by the construction of jetties, will give two excellent ports. The climate is remarkably healthy, and native labor abundant and cheap. It is located in a country which has a comparatively strong government.

The estimated total cost of maintenance and operation in lifting, hauling, and placing the vessel with its cargo in the water again, is less than thirty cents per ton of cargo carried.

The great doubt which must exist in the mind of the reader is in the practicability of lifting and hauling a loaded vessel. The method

proposed is very briefly this: to lift the vessel by an ordinary lifting-dock, distributing and equalizing completely the weight of the vessel by a system of hydraulic presses before the weight is brought upon the carriage which is to transport it. This is all done under the water, as the vessel rises out of it, and in such a manner as to be perfectly safe and easy for the vessel. The weight is finally placed upon the carriage in such a way that there is no more weight upon one wheel, or upon one part of the carriage in its length or width, than upon another. The weight upon no wheel will be over eight or nine tons, although they will be tested to twenty tons when manufactured. The whole load is transferred to the wheels by means of powerful springs, which will also be tested to twenty tons, and none of which will have imposed upon them in practice a weight of over eight and a half or nine tons. These springs not only give a perfect cushion for the vessel and carriage while being transported, but also serve to take up any slight irregularities there may be in the track. The system of supports designed, and shown in the working model, gives an area of support under the vessel from fifty to seventy-five times as great as that in the best lifting-dock in the world; and, moreover, these supports completely adjust themselves to the model of the vessel in each case. As it has been said frequently by practical experts in designing and building docks, and handling vessels in them, the *desideratum* is to have a sufficient number of adjustable supports, and this has been sought for in the plans for the work as shown in the model.

The railway road-bed will be about 50 feet in width; the width between the outer rails, about 30 feet. There will be six of these rails, weighing from 100 to 125 pounds per lineal yard. All six rails will be connected by a long steel-plated tie, set into two feet of broken stone ballast or concrete, as the case may be. The locomotive power as designed is to consist of engines of from 75 to 100 tons, each of which will haul at least 3,000 tons on a grade of as much as 40 feet to the mile; so that two, or at the most three, such locomotives will haul the maximum load. The grades are very light. Much of the line of railway is practically level. The maximum gradient, of which there is only one length of about 12 miles, is one per cent, or 52.8 feet per mile. The change between grades will be made by the ordinary vertical curve, but a very flat one, — one that will change from a straight line two inches in 400 feet. The railway is practically straight, the minimum radius being 20 miles. The line as laid down on the isthmus has curves of from 20 to 53 miles radius. At five points on the line, in order to avoid heavy mountain cuttings or very high embankments, a change of direction will be made by floating turntables, — a simple and economical device in first cost and operation, on which the vessels will be turned about while resting on a cushion of water. The whole line has been very carefully surveyed, and is practically located. Careful examinations have been made to ascertain the character of the foundations, both for the road-bed and for the masonry structures. The result of these examinations shows that there is no bad or even questionable ground anywhere between the two termini. The accompanying map shows the topography of the country and the route of the railway, the river to be navigated and the harbors on the two sides.

It will be seen from the foregoing that the vessel, when lifted out of the water, is really water-borne on a system of columns of water under pressure, and that, in the position given by this hydraulic system, she is transported across the isthmus. It will also be seen and appreciated by every person who is accustomed to travel on the ocean, that the strain to the vessel by the methods proposed can never be so great as that which she must undergo every time she goes to sea. E. L. CORTHELL.

THE WATER-SUPPLY OF BRESLAU.

THE results of Hulwa's numerous examinations of the waters of Breslau made during the years 1876–81, and which, up to that time, had appeared only in fragmentary official reports hardly obtainable even by specialists, were brought together into a single paper on the occasion of the German health exhibition in 1882–83. This paper, recently published, is of great value to all interested in water-supply.

As far as the well-waters are concerned, the numerical results are given only in selections and averages, and are, indeed, mainly of local interest. The story is essentially the same as may be told of any compactly built city, especially of the older parts, where the same houses have been occupied for hundreds of years. Of a hundred and fifty wells examined, less than ten per cent furnished water really good enough to use, and only two or three water which was above all suspicion.

Since the year 1871, Breslau has enjoyed a supply of water from the river Oder. The works are situated above the city, and the water is subjected to a thorough filtration through beds of sand and gravel.

Beiträge zur schwemmkanalisation und wasserversorgung der stadt Breslau. Von Dr. FRANZ HULWA. (Ergänzungshefte zum Centralblatt für allg. gesundheitspflege, I. ii. Bonn, 1884.)

From numerous examinations of the Oder water before and after filtration, Hulwa concludes, that, with the exception of occasional disturbances at times of high water, the impurities of the river-water are so far removed by the process of filtration as to furnish a drinking-water almost above suspicion. In order to remove the fine particles of clay which give to the water, in times of flood, an opalescent appearance which filtration will not remove, Hulwa recommended treating the water, before filtration, with alum in the proportion of from one to ten parts of alum to a hundred thousand parts of water (by weight), according to the degree of turbidity of the water. This use of alum, which is becoming very common on a smaller scale, has not been adopted at Breslau. At the time of Hulwa's examinations, the sewage of Breslau all ran into the Oder opposite and below the city, in anticipation of the completion of the sewage-farms now in use. The study of the effect of this discharge upon the stream is perhaps the most interesting part of the document. Although the volume of sewage is, on the average, only $\frac{1}{148}$ of the volume of river-water, and in times of flood only $\frac{1}{317}$, the river opposite and just below the city gives abundant evidence of pollution, — pollution which becomes less and less marked as the stream flows. Thirty-two kilometres below the city neither chemical nor microscopical examination was able to show any evidence that the water was not quite as suitable for water-supply (after filtration) as the water from the same stream above the city at the present pumping-works. Hulwa is of the opinion that the natural purifying agencies are quite sufficient to take care of the amount of sewage which was then discharged into the river, and that, *a fortiori*, the effluent from the sewage-farms may be safely disposed of in that way. He is careful, however, to admit the possibility of overloading this or any other stream, and of calling upon the natural agencies to do more than they are capable of doing. He thus agrees with most experts who have studied this matter, that the discharge of sewage or other polluting matters into a stream is not to be decided in all cases by an absolute prohibition, but that the size of the stream, the proportion of polluting matters, and other circumstances, must be taken into consideration.

THE CONSUMPTIVE PERIOD.

HIPPOCRATES declared that consumption gathers the greatest number of victims between the ages of 25 and 35 years, and the same observation holds true to-day.

As a first and natural deduction from this fact, the opinion has obtained, that men are more susceptible to consumption between 20 and 35, and that, passing this period, they gradually acquire an immunity from the disease.

A more careful study of the statistics, however, reveals a fallacy in this reasoning. Hitherto it has been the custom to reckon the mortality of each period of life as a fraction of the entire mortality of all ages. By this method it is shown merely that during certain decades of life more individuals die of phthisis than during other decades. This amounts, however, simply to saying that within these periods of life a greater number of people are living. The total number of deaths from any disease, at any given age, must be greater or less, according to the number of people existing at that age; and a large proportion of mankind are from 20 to 35 years old. In order, therefore, to determine the individual risk of consumption at any specified time of life, it is necessary to know the whole number of persons living at that age, and then compute the percentage of them who die of consumption.

Figuring in this manner, Würzburg estimated the annual percentage of mortality from phthisis at different periods of life in Prussia, and he found the following table for every 10,000 persons living at each period: —

AGE.	MEN.	WOMEN.	AGE.	MEN.	WOMEN.
0–1	24.95	21.92	25–30	40.04	33.58
1–2	20.27	20.55	30–40	44.25	38.12
2–3	12.00	12.94	40–50	57.10	40.10
3–5	6.43	7.18	50–60	82.38	54.48
5–10	4.07	5.26	60–70	112.25	76.09
10–15	4.35	7.38	70–80	75.23	50.03
15–20	17.87	18.87	Over 80	31.71	21.01
20–25	34.77	25.93			

From this table it is seen that a large phthisis mortality prevails during the first year of life; thence it descends to a minimum between 5 and 15 years of age; from this point it increases with rapid strides, until, between 60 and 70 years, it reaches the high figures of 112.25 per every 10,000 living beings of that age: in other words, these figures mean that a man's liability to death by consumption increases from puberty till 70 years of age.

The companion column of the phthisis mortality of women shows that they are more frequent victims during childhood, but during the third decade and thereafter their relative liability is diminished.

These figures of Würzburg are confirmed in their main features by the investigations of Lehmann in Copenhagen, and of Schmitz in Bonn. Lehmann also extended his query to the relative duration of phthisis at different ages, and found that under 20 years of age more than 75% of phthisis patients die within a year. This rapid progress of the disease diminishes with increasing years until at least one-half of the cases terminating after 55 years of age present a record from three to many years' duration. It follows from this that a portion of the increased phthisis mortality of advanced years is due to cases which have lasted over from the earlier decades.

Die schwindsuchtssterblichkeit in den dänischen städten im verhältniss zu der lebenden bevölkerung in den verschiedenen altersklassen und geschlechtern. Von Dr. JULIUS LEHMANN. (Ergänzungshefte zum Centralbl. allg. gesundh., 18 p., pl. 8°. Bonn, 1884.)

Ueber den einfluss des geschlectes und des lebensalters auf die schwindsuchtssterblichkeit. Von Dr. JACOB SCHMITZ. Bonn, 1884.

THE BERLIN EXHIBITION OF HYGIENE IN 1882-83.

THE committee having in charge the preparations for, and the direction of, the German exhibition of hygiene, decided wisely, it seems to us, to substitute for the usual premiums a scientific report upon all objects shown, and possessed of real merit. At the close of the exhibition in the autumn of 1883, the work of preparing this report was placed in the hands of Dr. Börner of Berlin. The first part of his report has recently been published, and is soon to be followed by a second and concluding volume. This report contains a number of papers upon topics of the greatest interest to students as well as to the interested general reader. Drs. Wolffhügel, Sell, Löffler, König, and Baginsky, among others, have contributed, each in his own field of work, articles that have all the value of special treatises upon the topics assigned to them.

This exhibition, which came into existence in consequence of the direct exertions of the Deutsches verein für öffentliche gesundheitspflege, was to have been opened in May, 1882. A fire, however, destroyed in a few hours the completed building and contents. A new and more secure structure, with a larger collection of articles, was ready in the following year, and was opened to the public on May 12, 1883, under the patronage of the Empress Augusta. This was not a display of new things only, but a very complete exhibition of what has been done, or is now doing, for the protection of human life. Many of the objects exhibited have been secured by the Prussian government as a foundation of a permanent museum of hygiene.

The author truly enough asserts that exact science is extending constantly its territory within the domain of hygiene, and then adds with equal satisfaction Prince Bismarck's official declaration that the best work of medical science lies, not in the curing of disease, but in the higher office of preventing it. A study of the German exhibition of 1883, and of that at London in 1884, shows once more that the Germans may fairly claim the leadership in the scientific investigation of questions that belong to hygiene, while to the English still belongs the credit for the technical execution that brings the results of these investigations to the protection of the public health.

Nothing in this exhibition attracted more notice than the pavilion of the Imperial health office, — a model building, containing a complete collection of the apparatus used in the investigations of the infectious diseases, and in the examination of articles of food. The relief plan of Berlin, prepared by Prof. H. Gruner for this exhibition, is another proof of the excellent work carried on in this city in the department of hygiene. The plan, in addition to the peculiarities of the surface of the ground, gives the soil in section to the ground-water level, making apparent to the eye the great difficulties in the way of a thorough system of drainage, now accomplished under G. Hobrecht's energetic direction. A visit to the very extensive and successfully managed irrigation fields of Berlin was an instructive addition to the plans and descriptions of this work shown at the exposition. In the years since the war of 1866, a very valuable work has been done in Berlin by an association of ladies, and largely under the direction of Frau Lina Morgenstern, in the people's kitchens, which are, in effect, schools for instruction in the proper and economical preparation of food. This was all well shown, together with a large collection of articles of food and drink in all stages of preparation, and also in all degrees of adulteration.

The best form of shoe is the subject of an instructive paper by Dr. F. Beely. The various forms of shoe tried in the German armies were exhibited, with indications of defects and merits, from the time of Professor Meyer's first publication at Zurich, in 1857, upon the proper shape of the shoe. The military authorities of Germany have made a careful study of the subject. The normal form finally adopted by them closely resembles a much-advertised English one.

Another public necessity, well represented in the exhibition, and made the subject of an exhaustive paper by Dr. Lassar, is that of baths and laundries. Among these stand easily first the public baths of Bremen, built in the years 1876–77, at an expense of a hundred and twenty-five thousand dollars, not including the cost of the land. A bath here, with all the conveniences of the best private house, may be had for twenty-five cents, while one provided with all that is really necessary can be had for six cents. It is not necessary to add, perhaps, that a large part of the capital was given.

Institutions for the care of the poor, prisons and reformatories, were well represented by plans, models, and statistical tables, notably the great prison at Plötzensee, containing at present a population of two thousand, and the workhouse at Rummelsburg, — both mod-

Bericht über die Allgemeine deutsche ausstellung auf dem gebiete der hygiene und des rettungswesen. Breslau, 1885. 8°.

els of their kind. Tenement houses and schools, as exhibited, present nothing of unusual interest. The first-named are distinctly inferior to the better English models.

This volume closes with a review by F. O. Kuhn, architect, in Berlin, of structures exhibited by plan, for the shelter of soldiers in times of peace. The most conspicuous example shown was the new caserne at Dresden, — a complex of buildings, containing shelter for seven thousand men. A characteristic feature of this caserne is the complete separation of the rooms for day use, sleeping, eating, washing, and working, — an arrangement from which the Saxon authorities already claim a marked improvement in the health of the inmates.

If Dr. Börner's second volume is as satisfactorily edited as this has been, the work will have a permanent place in the history of preventive medicine.

COMFORT AND LONGEVITY.

Josef Körösi is the director of the Bureau of statistics in Budapest, and he has apparently brought to his work a mind well adapted to the difficult task of handling figures in bulk. The essay which he presents to us under the above title was read in September last, before the Association of hygiene in Berlin, and in it he has confined himself to a few points only. He has endeavored to determine the influence which the varying pecuniary conditions of life, with their attendant privileges or privations, have upon the longevity of the people of his city. For convenience he recognizes four classes, according to their endowment in worldly goods; those who are very rich at one end of the category, and those who suffer from abject poverty at the other. Between these extremes lie the great mass of the people, whom he divides into the middle class and the ordinary poor.

He does not claim that his figures possess an absolute mathematical value, because he could not determine the number of living individuals in each category; but by excluding children under five years of age, and taking the average age of those dying during a period of eight years, he found that

The rich class averages	52 years of life.
The middle class averages	46 years 1.1 months of life.
The poor class averages	41 years 7 months of life.

From this it is obvious that the possession of wealth, and the resultant exemption from privation, lengthen the average life nearly ten years.

The second point which he studied was the relation existing between epidemic infectious diseases, and the pecuniary status of the different grades of the community. Upon this point he finds that poverty does not exercise a uniform influence upon the occurrence of these diseases: indeed, viewing them as a whole, the well-endowed, excepting the very richest, are more seriously afflicted than the poor.

Viewing the infectious diseases separately, he finds that cholera, small-pox, measles, and typhus are more prevalent among the poor, while diphtheria, croup, whooping-cough, and scarlet-fever are more prevalent among the rich. Consumption and pneumonia claim the poor, and brain-troubles attack the rich.

In view of legislative action regarding the abodes of the poor, Körösi next studied the influence of basement tenements upon the occurrence of epidemics; and he found, that, taking the infectious diseases as a whole, they are 60% more frequent in the cellar than in the elevated tenements.

The cellar residence, however, does not favor all diseases alike. Measles and whooping-cough are very prevalent there, croup less so, while diphtheria and scarlet-fever are 10% less frequent among cellar inhabitants than among those more loftily housed. This is in accordance with statistics from other places, and notably from Boston, where epidemics of diphtheria have swept over the finest parts of the city, and have left the low sections and cellar regions almost exempt.

Lastly, Körösi considers the influence of crowding upon epidemics. To obtain a standard, he noted the number of rooms in each house, and the number of people occupying them. Combining these figures, he obtained the average number of persons per room. A possession of one or two persons to each room was taken as normal, while three, four, and five persons per room were considered overcrowding. He found that the intensity of some infectious diseases was notably increased in the crowded tenements. This increase amounted to 364% for measles in houses inhabited by more than five persons per room. Whooping-cough is likewise greatly intensified by crowding. On the other hand, it does not appear that scarlet-fever and diphtheria are similarly favored by the increased number of people in the house. These are rather surprising conclusions, and may find their explanation when we discover the manner in which these various diseases are transmitted from person to person.

Ueber den einfluss der wohlhabenheit und der wohnverhältnisse auf sterblichkeit und todesursachen. Von Josef Körösi. Stuttgart, *Enke*, 1885. 8°.

ANIMAL DISEASES AND PUBLIC HEALTH.

THE object of this book is to introduce to the people of this country 'the higher purposes of veterinary medicine.' These higher purposes are the better protection of the public health, and the mitigation of certain evils relating to our food-supply.

The amount of capital invested in live-stock is enormous, and the animal product a most important part of our national resources. The better protection of this property from disease is discussed in the third part of the book. Writers have usually treated this material or pecuniary side as the more important aim of veterinary medicine: it is here, however, discussed as secondary to that of public sanitation. In part second the author gives an excellent history of veterinary medicine, and of veterinary schools in Europe, along with much information not easily accessible elsewhere.

This age of steam has in many ways stimulated the production of live-stock; and the relative proportion of animal to vegetable food has of late years been rapidly growing. This is in part due to the fact that the art of stock-breeding has greatly advanced, and in part to the modern facilities for the preservation and transportation of animals or their products. While this is, as a whole, doubtless a benefit to mankind, it has at the same time enormously increased certain dangers to public health. Old dangers have increased, and new ones been introduced that our fathers knew nothing of. Moreover, modern scientific investigation has traced to our domestic animals certain diseases of man the origin of which has heretofore been a mystery; and we now know that the public health is related to that of our domestic animals in more ways than the public yet appreciate.

Dr. Billings has therefore an important theme, and he tells his readers 'not to forget that the author is an enthusiast;' and we will add, that, like many enthusiasts, he advocates measures for the details of which, even if practicable, the public are by no means yet ready. Indeed, like the public, the author himself devotes the most attention to some of those dangers which are by no means the greatest, if we measure their results by mortuary statistics.

That the flesh of obviously diseased animals is unwholesome food for man, has been the common belief for ages; and communities that have any public markets at all have generally placed legal restraints on its sale. In most civilized countries, there are severe penalties for selling diseased flesh of certain kinds; but in our country the administration of sanitary laws in this direction is very defective, and the methods very faulty. In some directions there is, as yet, no official or organized effort to meet dangers the existence of which is reasonably well demonstrated.

We may say, in a general way, that the health of the people is directly related to that of their domestic animals in at least five ways. In the first place, some of their contagious diseases are directly transmissible to us, and are very fatal; and to this class belong some of the most dreaded of diseases. For example: in proportion to the relative number of its victims, hydrophobia inspires more terror than any other disease known to us, and greater exertions are made against it than against any other one disease which slays so small a proportion of the population. This, in man, comes only from animals. In the same category we may place anthrax and glanders, both very fatal. The foot-and-mouth disease of cattle, transmitted to man through the milk of diseased cows, is less fatal, perhaps, but still too troublesome, and unfortunately too common, to ignore, and others of less note are well known. The mortality in any community, due directly to this class of diseases, is relatively small; yet there is a positive danger, against which we have as yet inadequate protection, and where we especially need intelligent official action founded on proper veterinary authority.

Closely related to this is a class of diseases less contagious, and where the direct transmission to man does not so commonly follow exposure, or where, at least, the demonstration is as yet incomplete; where we can say that the public health may, and probably does, suffer, but where the proof is lacking, and the extent of the danger very uncertain. Such is the case with tuberculosis. That tuberculosis of cattle is very common in the old world, that it is less common here but is increasing, all who have studied it believe. That tuberculosis in man is in a degree transmissible, is, we think, now generally conceded; and that tuberculosis in cattle may be transmitted to other animals through the milk of tuberculous cows is proved. That it is transmitted from cattle to man through milk is not proved, but the analogies are most suspicious, and have of late attracted much attention. The author gives an excellent history of the investigation in Germany, and gives suggestive statistics of the extent of the disease among European cattle.

The relation of animal diseases to the public health, and their prevention. By FRANK S. BILLINGS, D.V.S. New York, 1884.

In the light of our present knowledge, few intelligent parents would knowingly allow their children to use the milk of tuberculous cows; but as yet we are powerless to prevent its sale in our cities.

A third class of diseases grows out of animal parasites in the flesh of the animals we use as food. Of these, trichiniasis has of late played the most sensational *rôle*. For the last few years this has been prominently before the public; but in our own country, curiously enough, our officials, because of commercial complications, have tried to hide the danger, rather than guard against it. Outside of the advertisements of quack medicines, no more astonishing sanitary literature can be found than some of the public, not to say official, utterances regarding trichinae in the swine of this country. Our author gives numerous statistics, both from other sources and from original investigations, which show that the disease is common enough and wide-spread enough to need more careful watching. Fortunately, each household can protect itself from this class of diseases by thorough cooking; but, considering the customs of cookery, there should be other protection. Tape-worm belongs in this class of diseases. We think that the author overrates the danger from the Taenia medio-canellata derived from beef (more probably from veal?), and quotes Thudicum of twenty years ago to show that the rarity of the cysticercus in beef makes it more dangerous, — a doctrine from which we entirely dissent. In this country the vast majority of tape-worms appears to be the T. solium which we get from 'measley' pork.

There is still another way in which the flesh of diseased animals probably affects the public health. Animals are subject to certain diseases which affect their flesh, but which are not, so far as known, transmitted to man. The so-called hog-cholera is such a disease; yet experience has shown the propriety of forbidding the sale of the pork in the markets when sufficiently affected to have the red spots.

The author advocates much more extensive inspection of animals, but we fear that his zeal has led him to impracticable lengths. When we consider the enormous number of animals slaughtered by the producers of the same on their own farms, and the production of milk on small farms not called 'dairy' farms, we fear that a system of inspection which will extend to 'all animals slaughtered,' and to all the cows on all the farms which may supply milk for sale, is impracticable. Nor would he, we think, have written that '*city inspection* [of milk] *is next to useless*,' if he had had any experience in official sanitation in a large city, drawing its milk-supply from regions over which its officers had no jurisdiction whatever. Because we cannot have the most perfect means of protection, it is nonsense to decry the only means that are available, and which, experience shows, make a great improvement in affairs. And, however necessary and important official inspection may be, one cannot hope for 'the unquestionable guaranteeing' of safety by any official board: that is asking a great deal.

His short chapter on hippophagy, as practised in Europe, is both interesting and opportune. The growing consumption of this cheap, nutritious, and wholesome meat is a good thing, which the next generation will doubtless find common in all enlightened countries. The poorest chapter in the book is that relating to infection and bacteria, some portions of which (and notably the botanic portion) are lame. But the book is an important one: it deals with an important subject, and is the repository of much useful information in an interesting and available shape.

HOUSE-DRAINAGE.

OF the numerous books which have appeared during the past year, devoted to this subject, many are too exclusively taken up with the plumbing and drainage of houses and tenements in cities and towns provided with sewerage systems. In Col. Waring's book, entitled 'How to drain a house,' the individual householder, to whom the volume is chiefly addressed, will find valuable counsel, whether his domicile is in a crowded city, or in a country or suburban village where connection with public sewers is impossible.

The great value to the state, of sanitary works, such as pure water-supplies and the proper drainage for the removal of sewage, has been successfully demonstrated, and the same principle is none the less true of each individual dwelling.

The first and principal portion of the book treats mainly of that portion of the drainage system which is included within the interior of the house. The closing two chapters are devoted to the disposal of the sewage of isolated houses, and the special method of sub-surface irrigation.

The style is concise, and the illustrations are clear and simple, and shorn of all unnecessary

How to drain a house. Practical information for householders. By GEORGE E. WARING, jun., M. Inst. C.E. New York, *Holt*, 1885. 222 p. 12°.

details. The reader is not left to lose his way among a bewildering array of traps, vents, and fixtures of every possible variety of style and shape. The writer addresses these chapters, not to plumbers, architects, or engineers, but, as he says, to "the limited class who are willing to learn, and with whom a promising suggestion becomes a fruitful germ; to the few who will agree with their teachings; and to the more who will take their propositions into earnest consideration, without the intention, and often without the result, of agreeing with them."

If the wise counsel offered in this volume were generally complied with, diphtheria, typhoid, and other filth-diseases would undoubtedly be reduced to a minimum, and the death-rate would show a corresponding improvement.

NOTES AND NEWS.

IF the air carries infectious germs, it certainly would be well to filter it before inhaling. We reproduce from *Science et nature* a cut showing a French physician of the time of the pestilence of Marseilles (1720–21) on his round of visits. He is incased in an armor consisting of a short morocco gown, a helmet of the same material, and a nose stuffed with aromatics, which, notwithstanding its being a doctor's nose, would prove an enlivening feature at a carnival. Did the doctors touch their patients only with the end of a stick? The illustration seems to indicate as much.

A FRENCH DOCTOR OF THE OLD SCHOOL.

—The conductor of the Cartographic institute, Hamburg, Herr L. Friedrichsen, writes thus concerning the limits of the German possessions in West Africa: "The Mahin district on the Gulf of Benin, between Lagos and the mouth of the Niger, settled by the Hamburg firm of G. L. Gaiser, has not yet been placed under German protection. The coast from Jaboo to Old Calabar will, in my opinion, be in future regarded as under British protection, but has not hitherto been officially placed under any European power. The frontier of the German Cameroon begins with the Ethiopian cataract on the Great River lying from there in a south-westerly direction, to the sources of the Rio del Rey, following the right bank of this river to the coast, then the coast-line in a south-easterly direction to the river Behuwe, excluding the town and neighborhood of Victoria as British, as well as the island of Malimba. The latter, as well as the whole coast from the river Behuwe to Gumbegumbe, is not described by me in the commissions of foreign officials as without a ruler, but as a tract on which the actual raising of the German flag is yet the subject of diplomatic treaty. The German protectorate in south-west Africa begins with 18° south latitude, not with Cape Frio."

—Prior to 1850, there were no effectual laws in England to regulate the number of hours of work per day for children and women: consequently they were in many places obliged to work from fifteen to sixteen hours daily. Certain laws had been passed, but they were so loosely drawn up that they were easily evaded. After 1850, practical laws were passed at frequent intervals, to protect the people in various kinds of industry, and ten hours and a half were made the extreme limit of work. A. Ollendorff has studied the mortality statistics of England for a series of years before and after 1850, and he finds that the mortality of women and children in manufacturing towns has notably diminished since these protective laws came in force.

—The *Oil trade review* reports that rich petroleum grounds have been found at Deli, on the east coast of Sumatra. After experimental borings, a well was found at a depth of thirty metres, which yields about three hundred and sixty gallons in an hour. When the last layer of earth was pierced, the oil rose in a strong volume to a height of two metres out of the bore.

—Reichemberg's system of employing the same wire for telegraphing and for the use of the telephone simultaneously, has been tried with great success between Toledo and Madrid.

—A committee has been formed in Stendal to put up a monument of the late Dr. Gustav Nachtigall, the African explorer and general consul so recently dead.

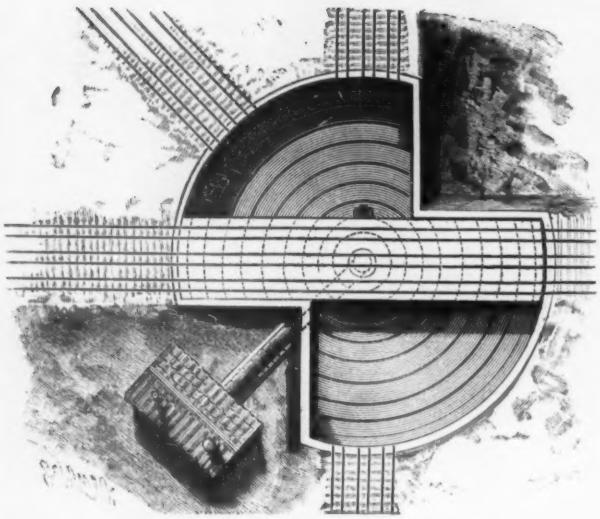


FIG. 1.—PLAN OF A TURNTABLE.

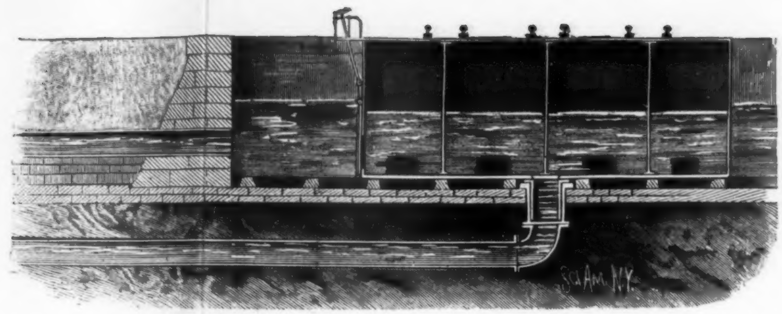
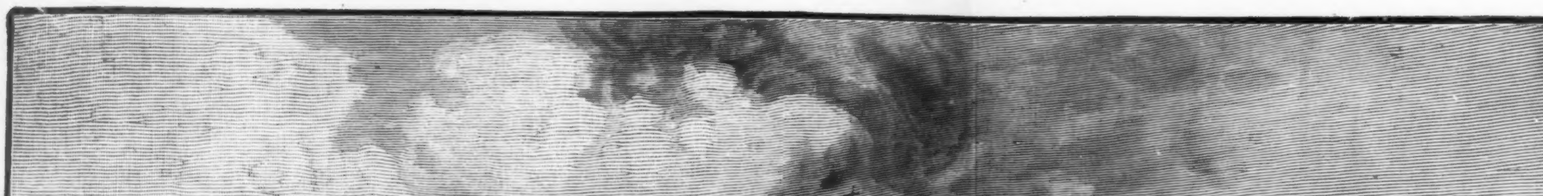
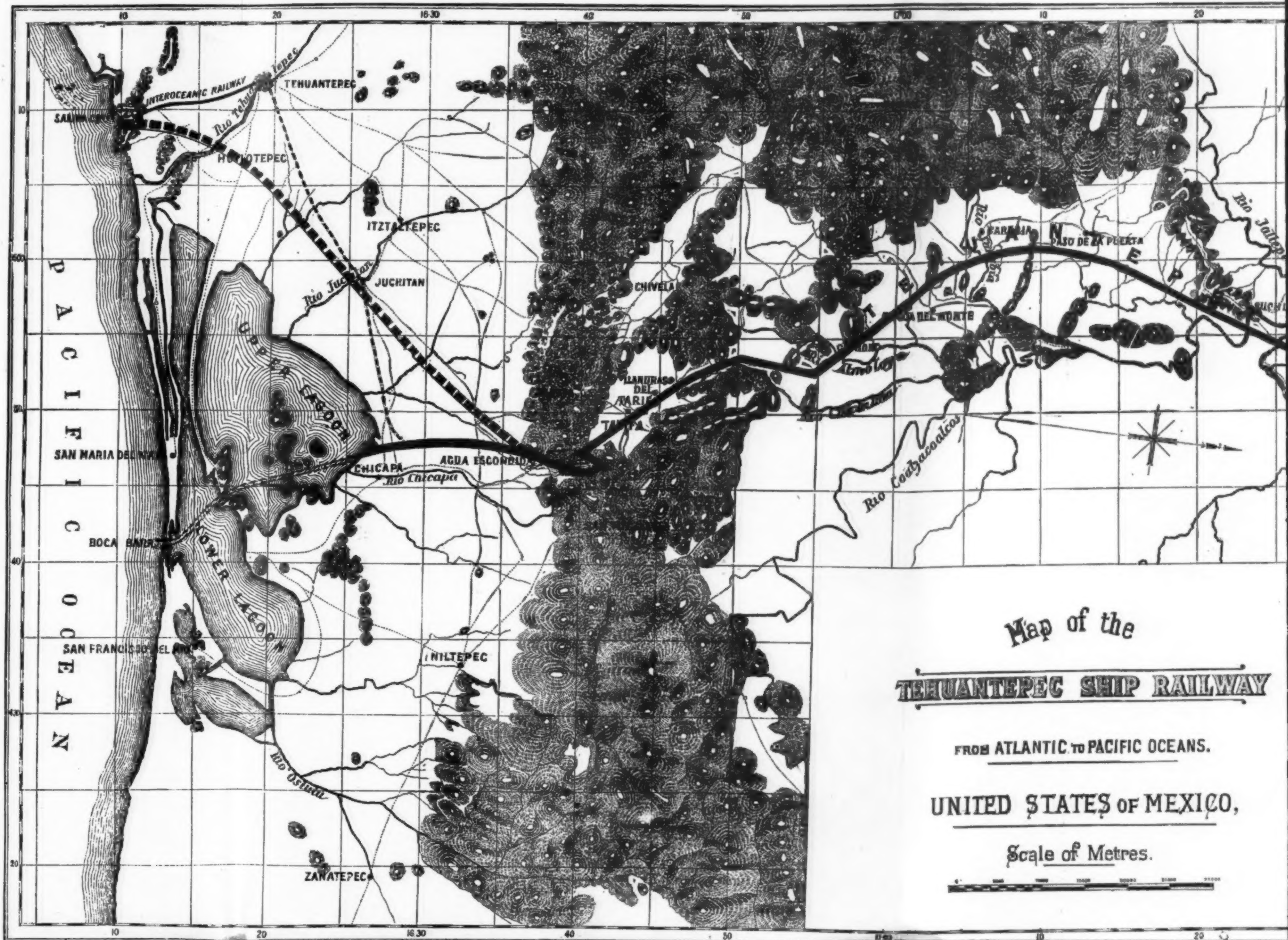


FIG. 2.—SECTION OF A TURNTABLE.




Map of the
TEHUANTEPEC SHIP RAILWAY
FROM ATLANTIC TO PACIFIC OCEANS.
UNITED STATES OF MEXICO,
Scale of Metres.
PACIFIC OCEAN
UPPER LAGOON
LOWER LAGOON
INTEROCEANIC RAILWAY
TEHUANTEPEC
Rio Tehuantepec
ITZTALTEPEC
JUCHITAN
Rio Juchitan
CHIVELA
CHICAPA
Rio Chicapa
AGUA ESCORRIDA
SAN MARIA DEL MAR
BOCA BARRA
SAN FRANCISCO DEL MAR
NILTEPEC
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Rio Jaltepec

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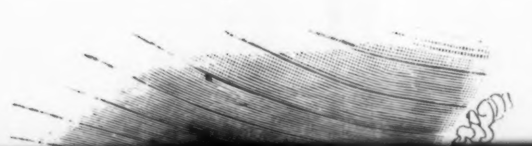

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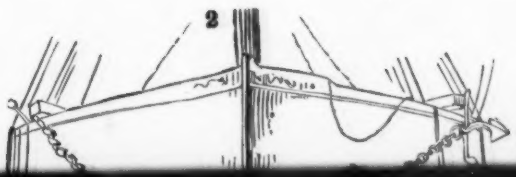

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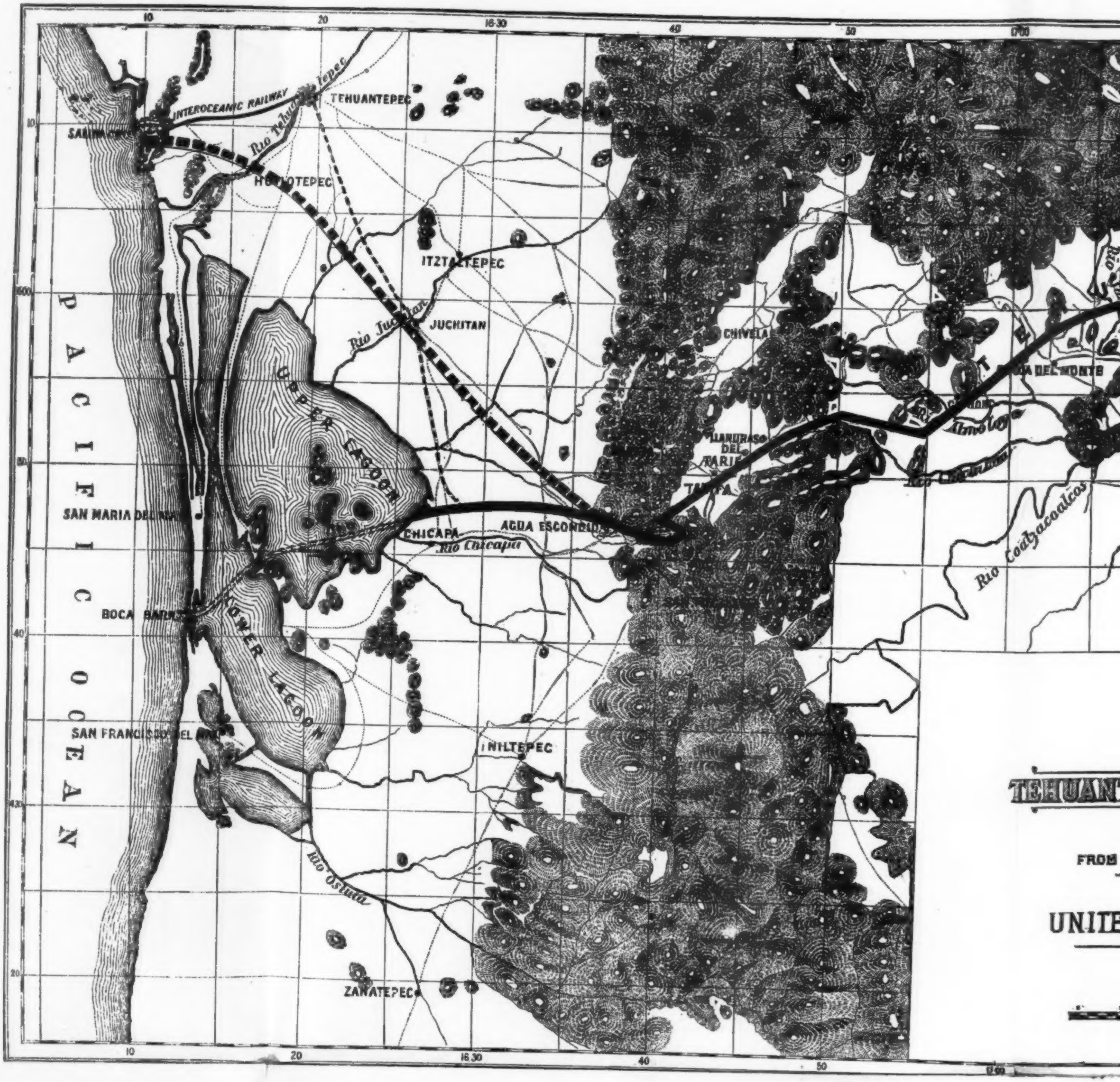
INTEROCEANIC RAILWAY
TEHUANTEPEC
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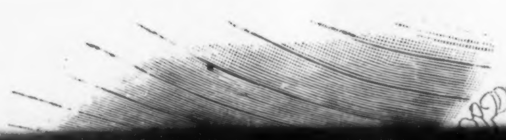

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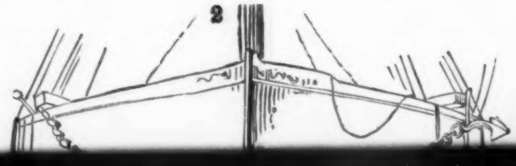

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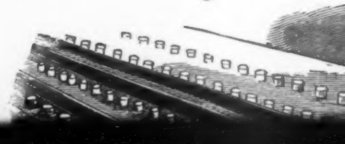
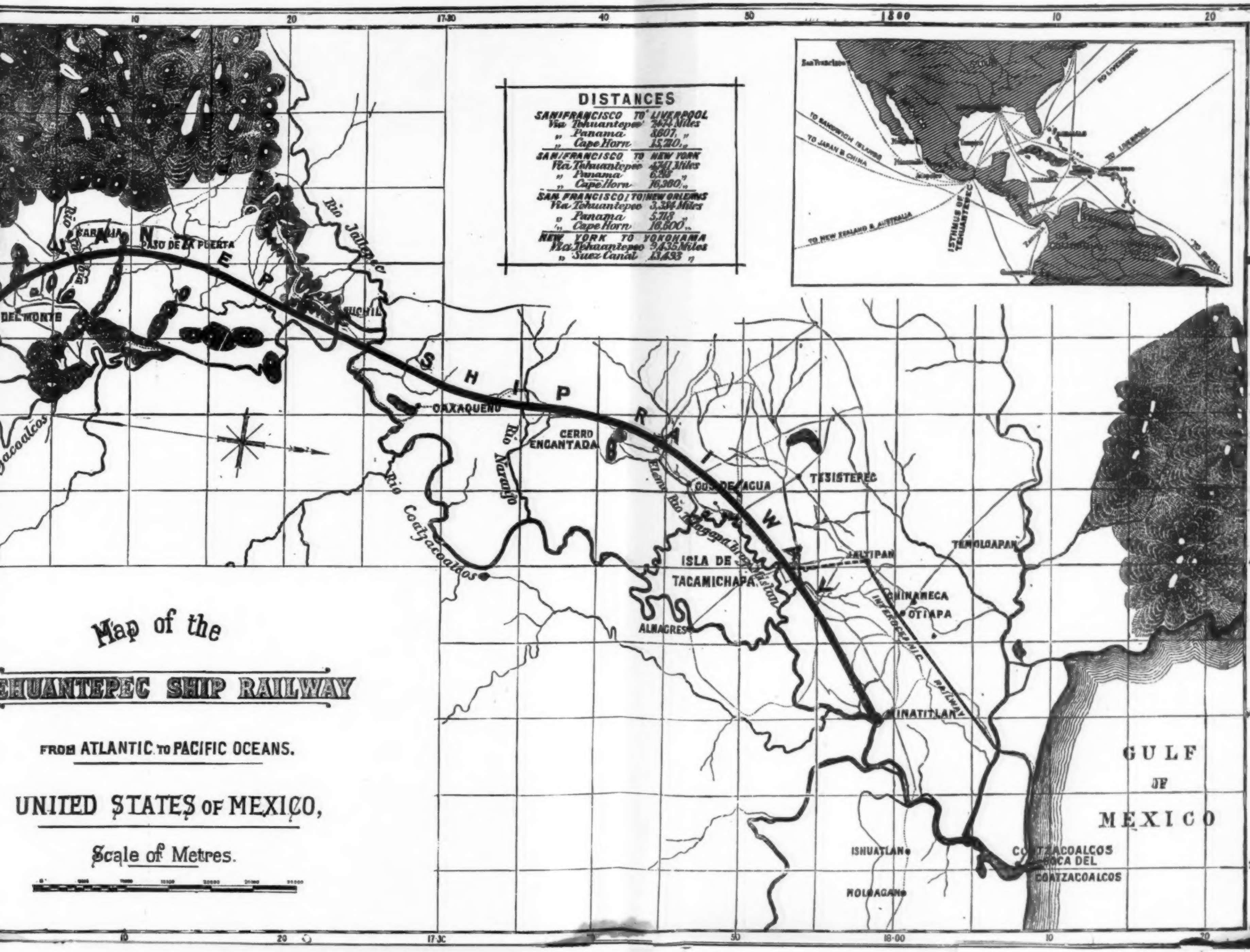



DISTANCES
SAN FRANCISCO TO LIVERPOOL
Via Tehuantepec 7474 Miles
" Panama 8607 "
" Cape Horn 15,210 "
SAN FRANCISCO TO NEW YORK
Via Tehuantepec 4747 Miles
" Panama 6,318 "
" Cape Horn 16,360 "
SAN FRANCISCO TO NEW ORLEANS
Via Tehuantepec 3,384 Miles
" Panama 5,718 "
" Cape Horn 16,600 "
NEW YORK TO YOKOHAMA
Via Tehuantepec 9435 Miles
" Suez Canal 13,493 "
ISTHMUS OF TEHUANTEPEC
TO NEW ZEALAND & AUSTRALIA
TO JAPAN & CHINA
TO SANDWICH ISLANDS
TO LIVERPOOL
SHIP RAILWAY
PASO DE LA PUERTA
DEL MONTE
OAXAQUENO
CERRO ENCANTADA
Rio Jaltepec
Rio Naranjo
Rio Coatzacoalcos
COSO DE AGUA
TESISTEPEC
TEMOLOAPAN
SALTIPAN
ISLA DE TACAMICHAPA
CHINAMECA
OTIAPA
ALMAGRES
INTEROCEANIC RAILWAY
MINATITLAN
ISHUATLAN
MOLOAGAN
COATZACOALCOS
BOCA DEL COATZACOALCOS
GULF OF MEXICO
Map of the
TEHUANTEPEC SHIP RAILWAY
FROM ATLANTIC TO PACIFIC OCEANS.
UNITED STATES OF MEXICO,
Scale of Metres.

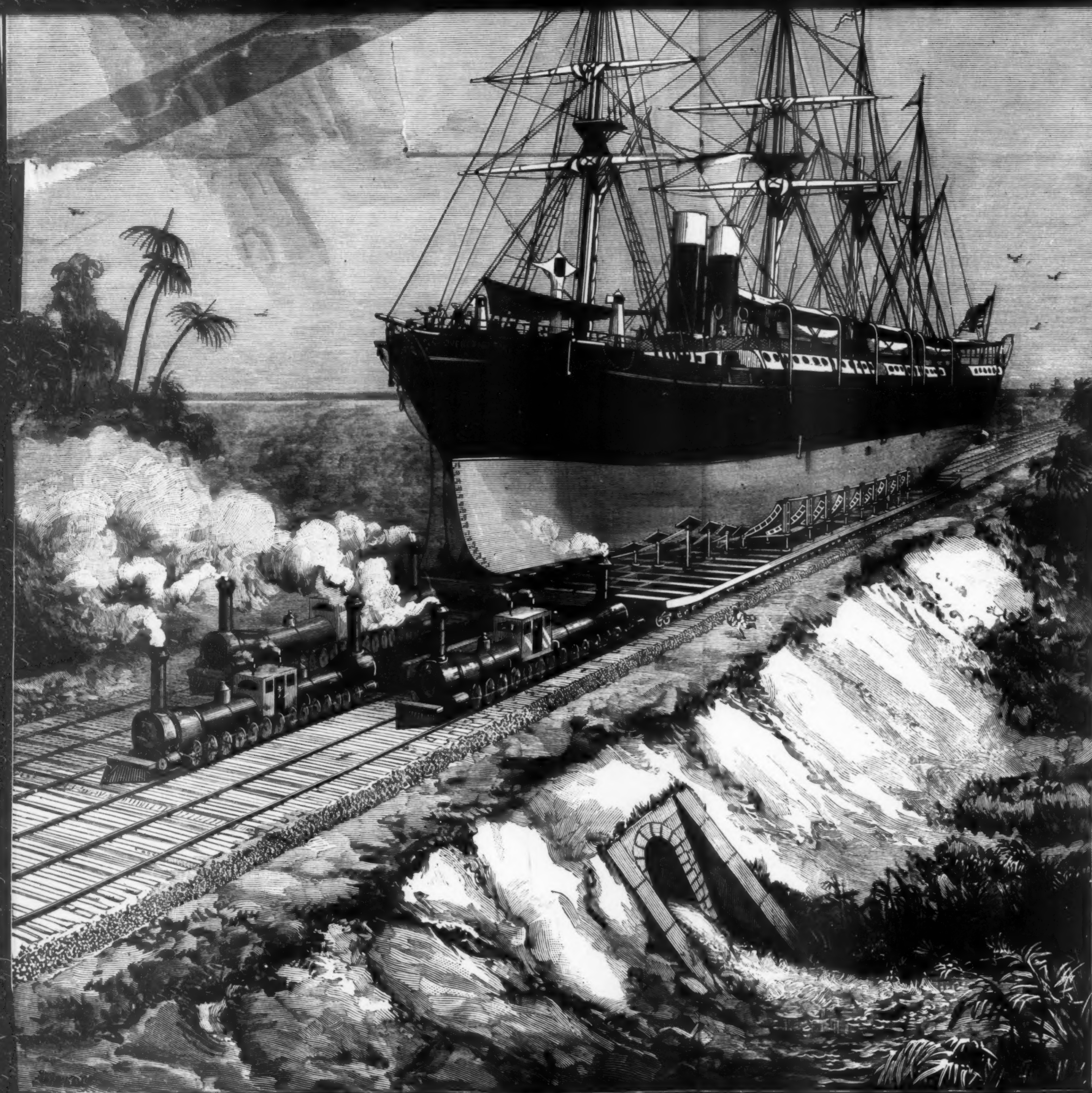
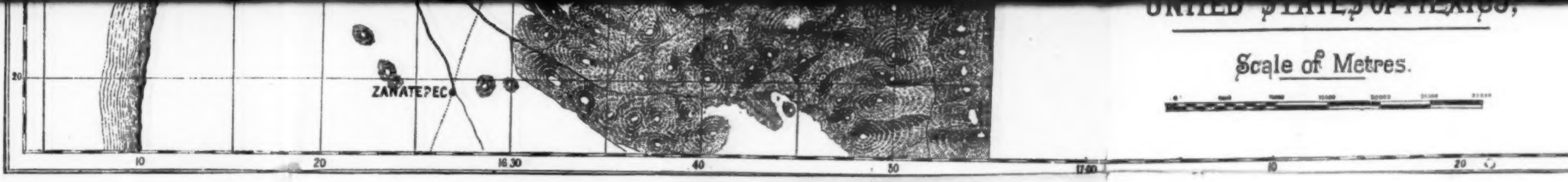


FIG. 3.—A STEAMER IN TRANSIT.

MAP OF THE PROPO



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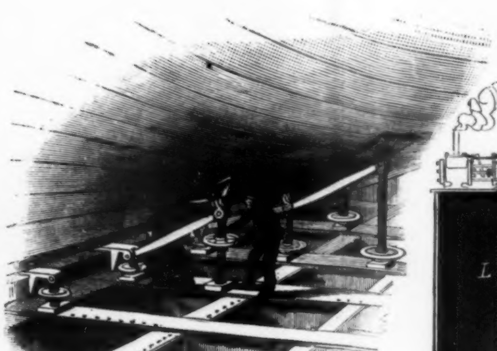

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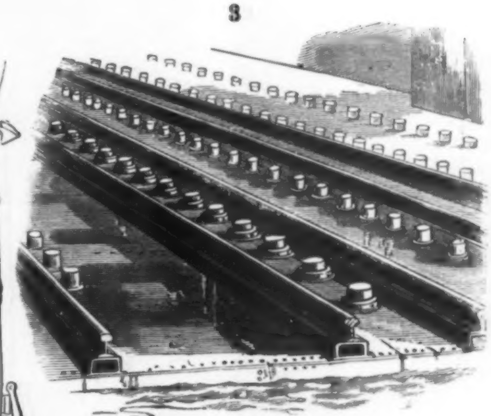

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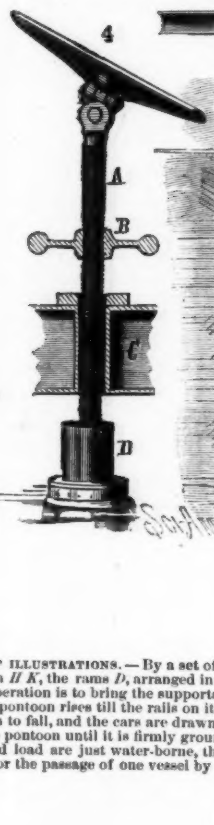


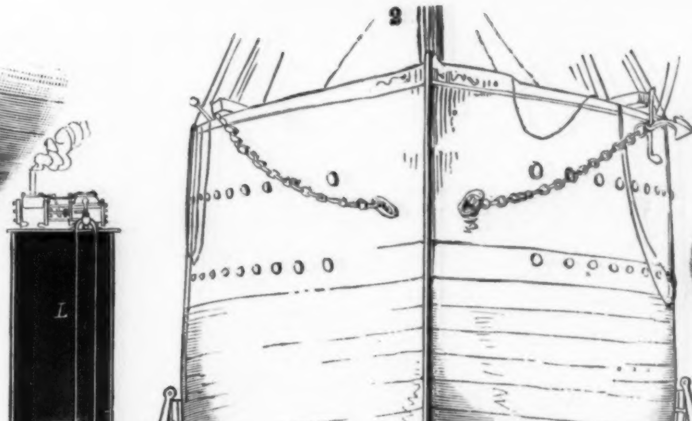
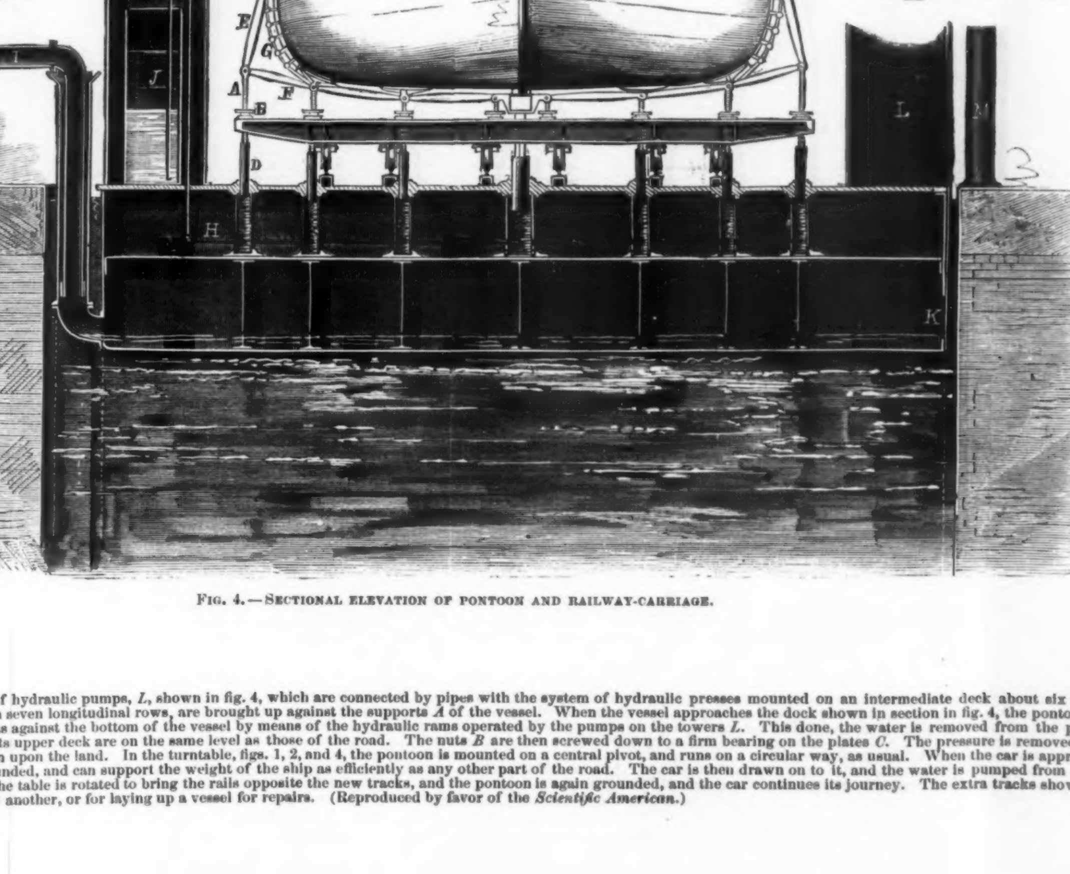
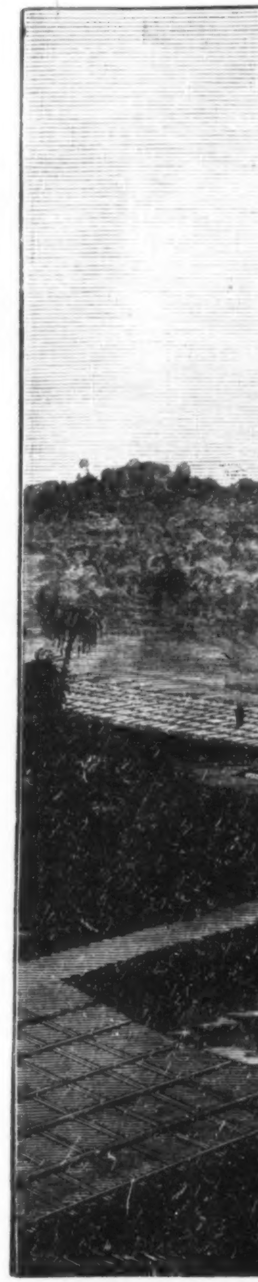
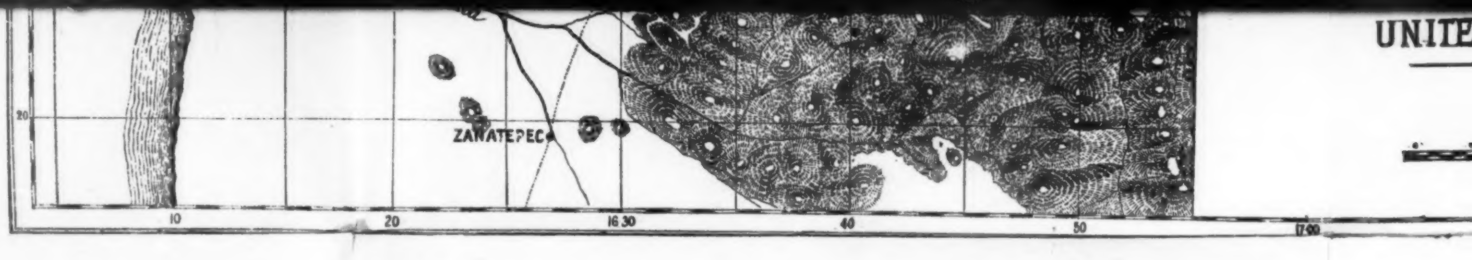



FIG. 4.—SECTIONAL ELEVATION OF PONTOON AND RAILWAY-CARRIAGE.



EXPLANATION OF ILLUSTRATIONS.—By a set of hydraulic pumps, *L*, shown in fig. 4, which are connected by pipes with the system of hydraulic presses mounted on an intermediate deck about six feet below the surface of the pontoon *H K*, the rams *D*, arranged in seven longitudinal rows, are brought up against the supports *A* of the vessel. When the vessel approaches the dock shown in section in fig. 4, the pontoon rests upon the bottom. The first operation is to bring the supports against the bottom of the vessel by means of the hydraulic rams operated by the pumps on the towers *L*. This done, the water is removed from the pontoon through the pipe *I*, and the pontoon rises till the rails on its upper deck are on the same level as those of the road. The nuts *B* are then screwed down to a firm bearing on the plates *C*. The pressure is removed from the rams *D*, which allows them to fall, and the cars are drawn upon the land. In the turntable, figs. 1, 2, and 4, the pontoon is mounted on a central pivot, and runs on a circular way, as usual. When the car is approaching, water is allowed to enter the pontoon until it is firmly grounded, and can support the weight of the ship as efficiently as any other part of the road. The car is then drawn on to it, and the water is pumped from the pontoon. When the pontoon and load are just water-borne, the table is rotated to bring the rails opposite the new tracks, and the pontoon is again grounded, and the car continues its journey. The extra tracks shown in fig. 5 are to be used as sidings for the passage of one vessel by another, or for laying up a vessel for repairs. (Reproduced by favor of the *Scientific American*.)

E PROPOSED TEHUANTEPEC SHIP-RAILWAY, AND ILLUSTRATIONS SHOWING THE VARIOUS APPLIANCES TO BE USED ON THE RAILWAY.



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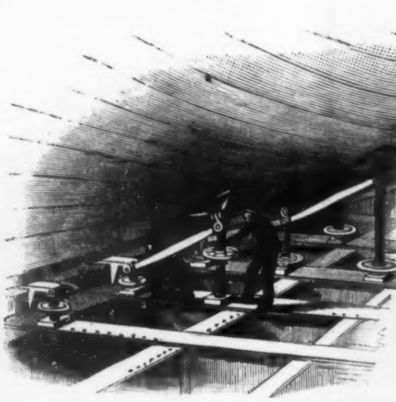

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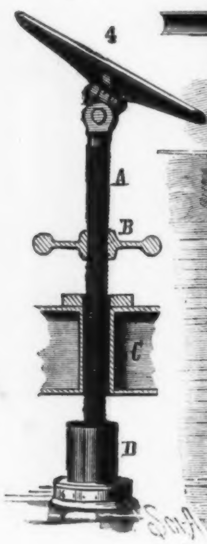

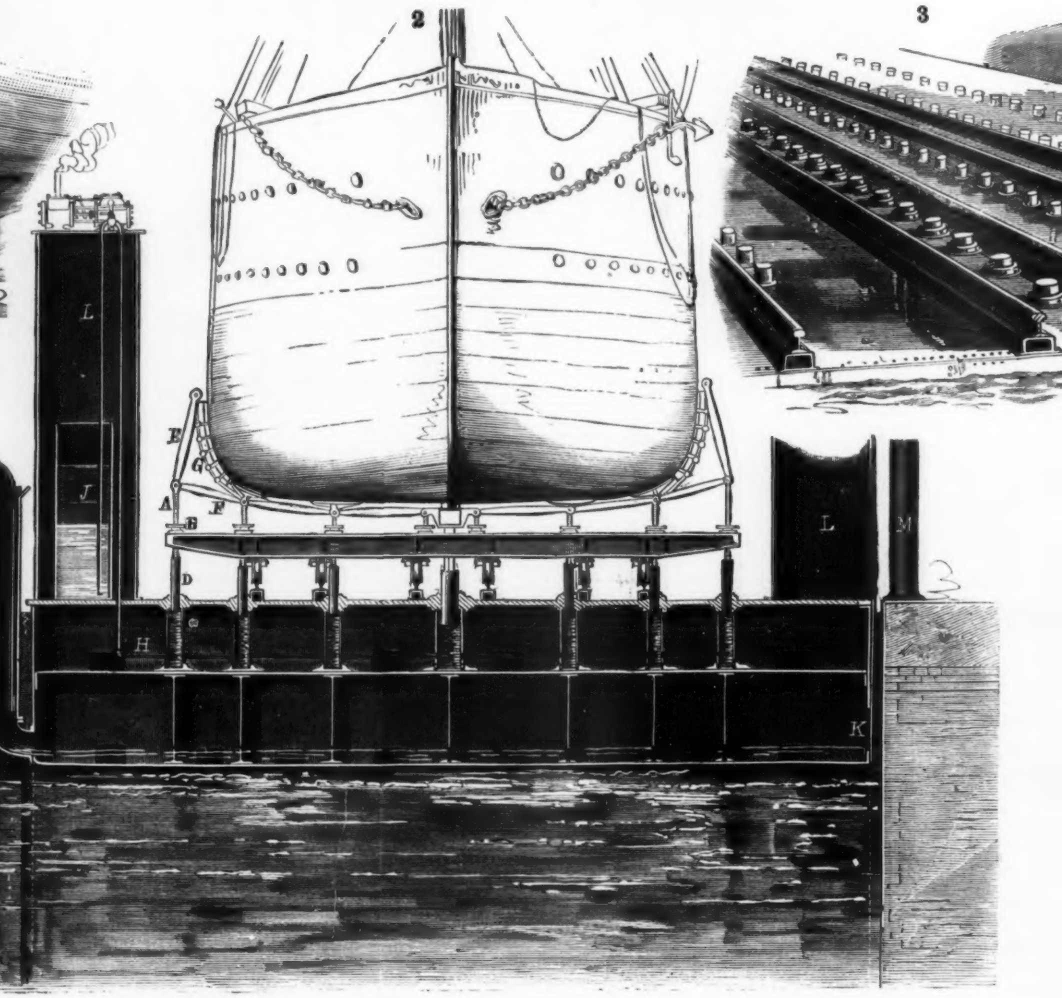

FIG. 4. — SECTIONAL ELEVATION OF PONTOON AND RAILWAY-CARRIAGE.

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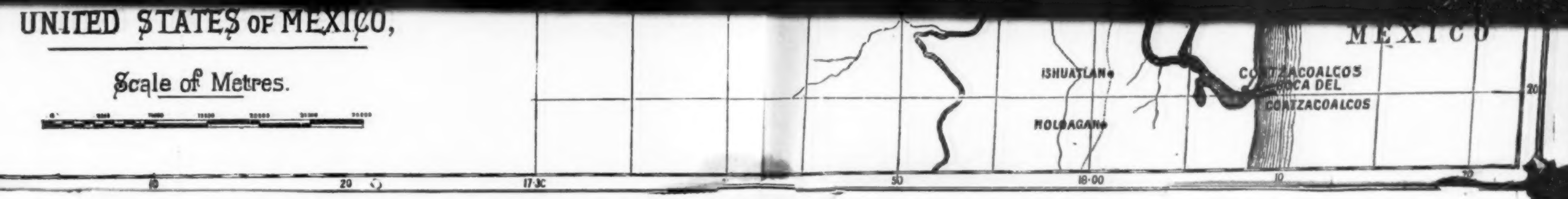
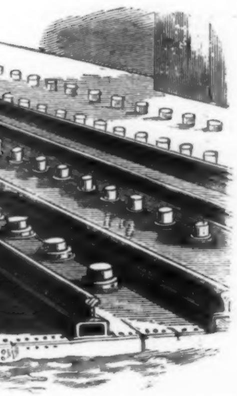
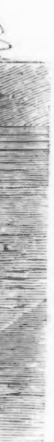
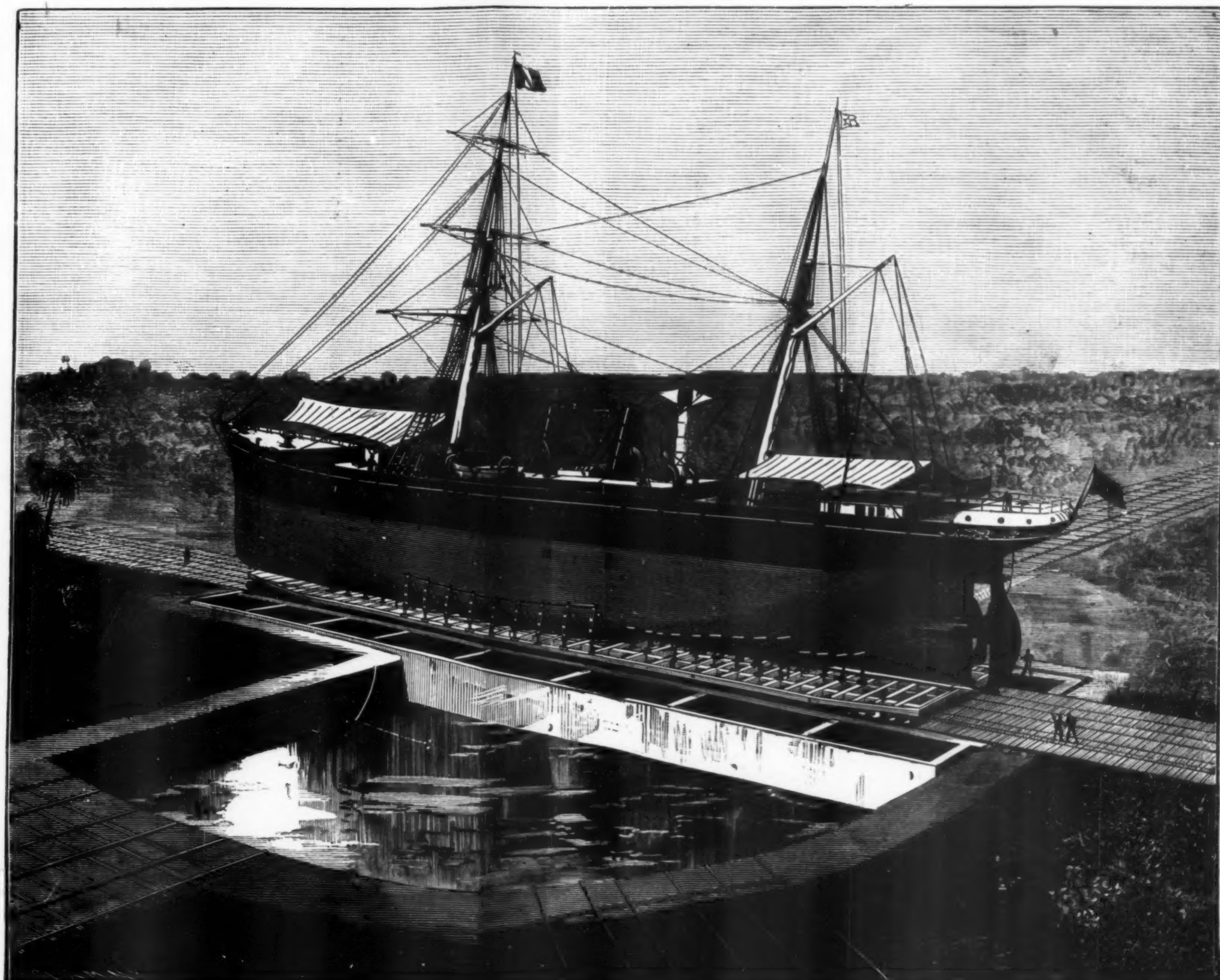
MAP OF THE PROPOSED TEHUANTEPEC SHIP-RAILWAY, AND ILLUSTRATIONS SHOWING THE VARIOUS APPLIANCES TO I









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pontoon rests upon the bottom.
the pontoon through the pipe
emoved from the rams *D*, which
s approaching, water is allowed
from the pontoon. When the
s shown in fig. 5 are to be used

FIG. 5.—ONE OF THE FLOATING TURNTABLES FOR CHANGING THE DIRECTION OF A VESSEL.

ES TO BE USED ON THE RAILWAY.